केंद्रीय भूमि जल बोर्ड

जल संसाधन, नदी विकास और गंगा संरक्षण मंत्रालय

भारत सरकार

Central Ground Water Board

Ministry of Water Resources, River Development and Ganga Rejuvenation

Government of India

**Report**

**on**

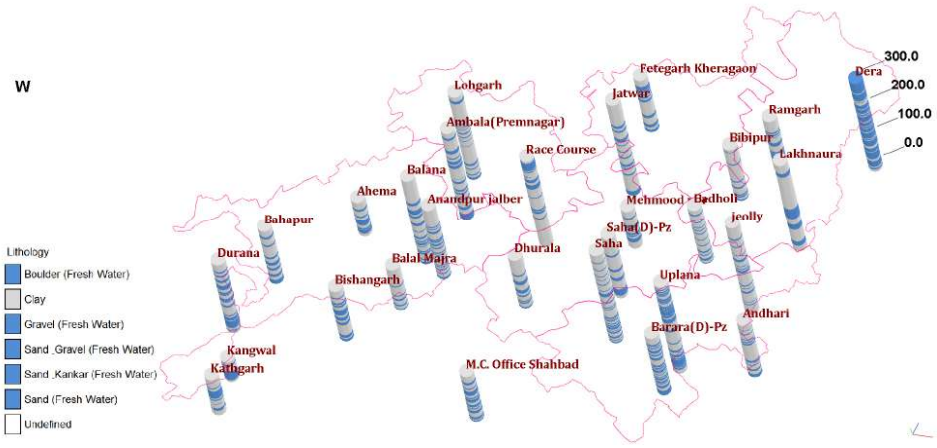
# AQUIFER MAPPING AND MANAGEMENT PLAN

## Ambala District, Haryana

उत्तरी पश्चिम क्षेत्र, चंडीगढ़

North Western Region, Chandigarh

# AQUIFER MAPPING & MANAGEMENT PLAN
# AMBALA DISTRICT
# HARYANA




**Central Ground Water Board**
**North Western Region, Chandigarh**
**Ministry of Water Resources, River Development and Ganga Rejuvenation**
**Government of India**
**2016**

# AQUIFER MAPPING AND MANAGEMENT PLAN

# AMBALA DISTRICT (1595.85 Sq Km)

# CONTENTS


1. **INTRODUCTION**
2. **DATA COLLECTION AND GENERATION**
3. **HYDROGEOLOGY**
4. **GROUND WATER RESOURCES**
5. **GROUND WATER ISSUES**
6. **AQUIFER MANAGEMENT PLAN**
7. **BLOCKWISE AQUIFER MAPS AND MANAGEMENT PLAN**
    i. **AMBALA-I BLOCK**
    ii. **AMBALA-II BLOCK**
    iii. **BARARA BLOCK**
    iv. **NARAINGARH BLOCK**
    v. **SHAHZADPUR BLOCK**
    vi. **SAHA BLOCK**
8. **CONCLUSION**

## LIST OF FIGURES

Fig 1: Base Map of Ambala District.

Fig1.2: Depth to Water Level Map (Pre-monsoon, 2015)

Fig 2: Location of PHED Wells.

Fig 3: Location of Private Wells.

Fig 4: Validated Exploration Data of Ambala District.

Fig 5: Elevation Contour Map- Ambala District.

Fig 6: 3Dimension location of validated Exploratory Wells with litholog.

Fig 7: 3Dimension Lithological Model of Ambala District.

Fig 8: 3Dimension Lithological Fence of Ambala District.

Fig 9: 3Dimension Aquifer model - Ambala District.

Fig 10: Cross sections of Aquifer - Ambala District.

Fig 11: Concept for Resource Estimation in Unconfined and Confined Aquifer System

Fig 12: Long term ground water table variation

Fig 13: Irrigation tube wells as per depth.

## LIST OF TABLES

Table 1: Data availability of exploration wells in Ambala district.

Table 2: Summary of optimized exploration wells.

Table 3: Aquifer grouping in Ambala district.

Table 4: Dynamic ground water resource & development potential (as on 31.03.2013).

Table 5: Block wise in-storage groundwater resources in unconfined(aquifer I)

Table 6: Block wise in-storage ground water resources - confined (aquifer II).

Table 7: Block wise in-storage ground water resources - confined (aquifer III-upto300m).

Table 8: Block wise total available ground water resources in aquifers up to 300m depth.

Table 9: Distribution of Tube wells according to owner's holding size

Table 10: Type of Ground Water Distribution Device

Table11: Scope of quantitative impact on stage of development after applying various management strategies.

## ANNEXURES

Annexure I: Depth to water level of GWOW (2015).

Annexure II: Results of chemical analysis of water samples from NHS (2015).

# AQUIFER MAPPING AND MANAGEMENT PLAN
# AMBALA DISTRICT (1595.85 Sq Km)

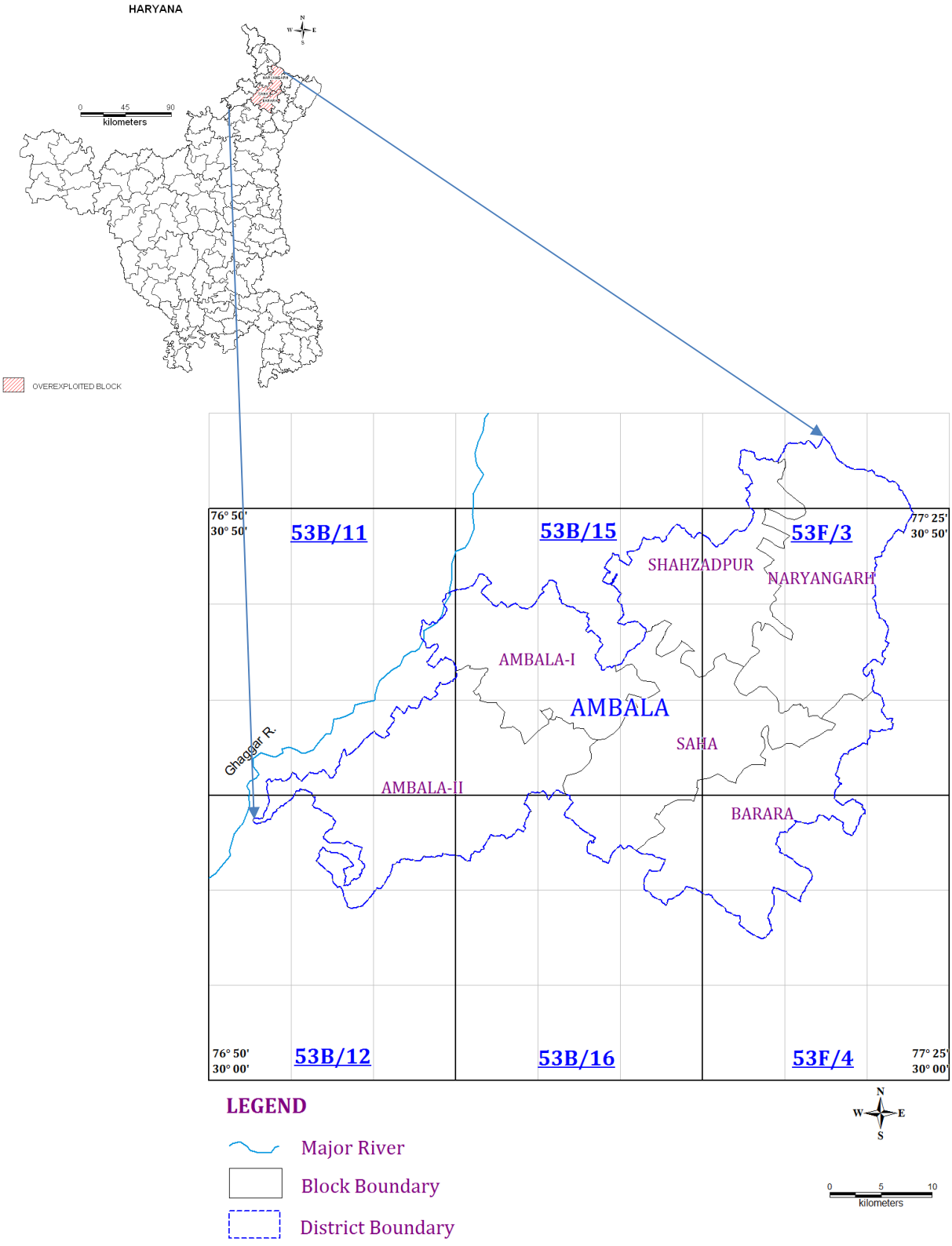
## 1. INTRODUCTION

### 1.1 GENERAL

Ambala district of Haryana lies between 30° 10' to 31° 35' north latitudes and 76° 30' to 77° 10' east longitudes. Total geographical area of the district is 1595.85 sq.km. It is divided into three tehsils namely Ambala ,Barara and Naraingarh, and sub-divided into six development blocks namely Ambala I, Ambala II ,Barara, Shahzadpur, Naraingarh, and Saha (Fig 1). The district area falls in Yamuna sub-basin of Ganga basin, and drained by streams Tangri, Beghna and Markanda. The normal annual rainfall of the district is 1076 mm, and is unevenly distributed over the area. The average rainy days are 44. The district area is occupied by Indo-Gangetic alluvium & flat terrain. A small area in extreme northeastern side of the district is occupied by dissected rolling plains of Siwalik range. The area slopes towards southwest with an average gradient of 1.5m/km. The soils are non-calcareous and sandy loam on the surface, and loam to clayey loam at depth, classified as Udipsamments/Udorthents.

The district is occupied by Indo-Gangetic alluvial plain of Quaternary age. There are thick alluvial deposits in the district. In south west and western parts of the district, sediments are fine grained in nature and comprises of sand, clay, silt and kankar with occasional gravel. The clays are usually brown to yellowish and sticky to silty in nature. The sands are usually fine grained leading to difficulty in development of tubewells to give sand free water. However, east and south eastern parts of the district are underlain by clay beds/ lenses and sands beds which are medium to coarse grained.

**Fig.1: Base map of Ambala District**



## 2. DATA COLLECTION AND GENERATION

### 2.1 Exploratory & Geophysical

The Lithologs of Exploratory Well/ Observation well/ Piezometer/ productive wells of CGWB, Public Health and Engineering Department (PHED) and private wells have been collected and those supported electrical logs have been validate for aquifer map preparation. Deeper well data of CGWB is available. The details are shown in table no. 1. The compromised logs derived from lithologs and geophysical well loggings have been taken as reliable data base. Geophysical Studies (VES) have also been conducted in the area. Two no. of VES has been conducted in the Barara block.

**Table No. 1: Data availability of Exploration Wells in Ambala District**

| S. No. | Source | No. of wells | Depth | |
|---|---|---|---|---|
| | | | <200m | >200m |
| 1 | CGWB | 33 | 20 | 13 |
| 2 | Private | 46 | 31 | 15 |
| 3 | PHED | 530 | 463 | 67 |

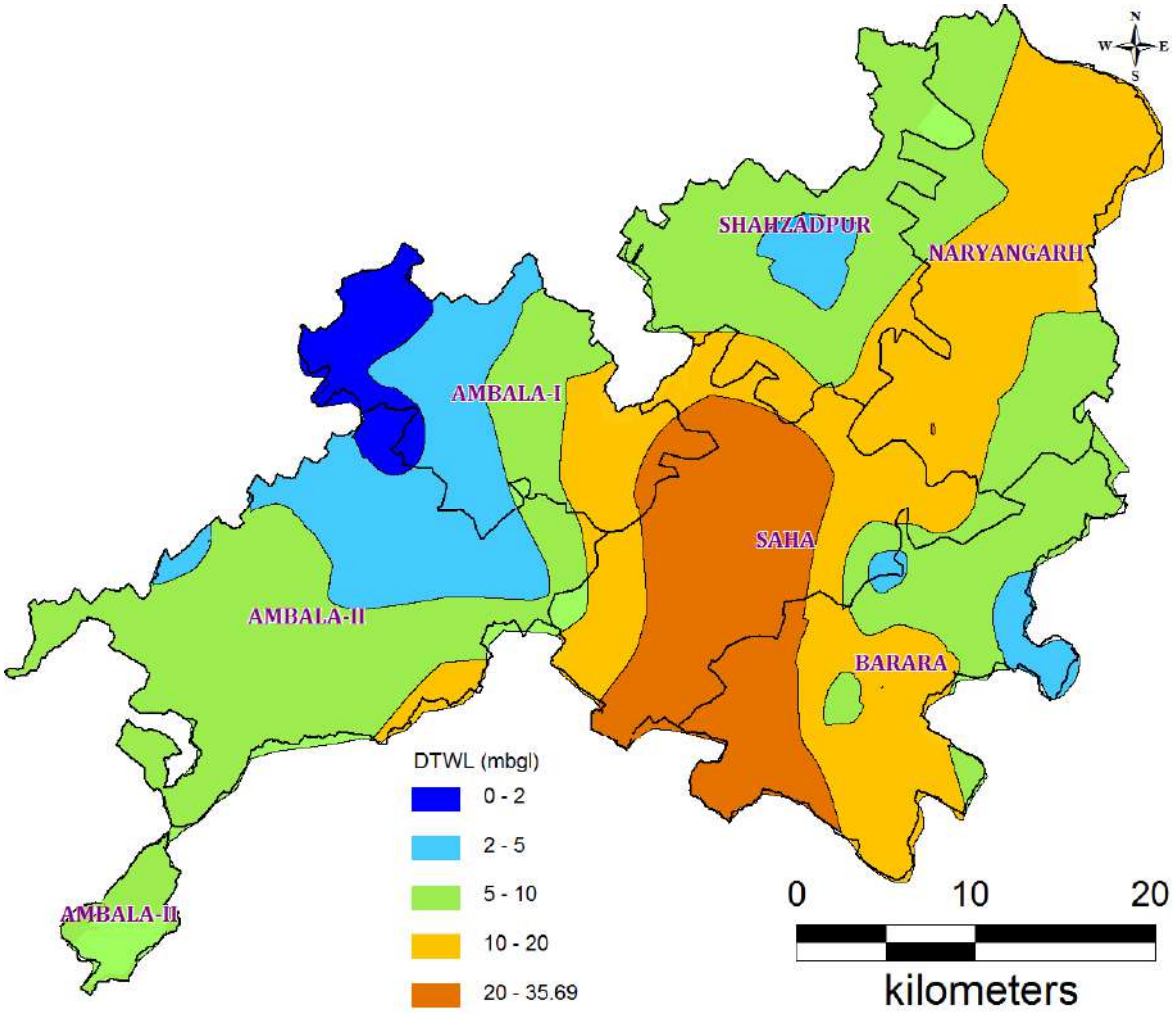
### 2.2 Water Level Behaviour (2015)

The depth to water level ranges from 1.099m bgl at Ambala city to 35.69m bgl at Tharwa during pre-monsoon and 0.70m bgl to 35.67m bgl during post-monsoon. Majority of the wells showing rise in the water level in post-monsoon which ranges from 0.02m at Saha to 3.92m at Churmastpur. The fall in the water level ranges from 0.51m at Nikuwana to 2.23m at Naraingarh. The depth to water level data and its fluctuation is given in Annexure I.

The long term trend in the water level reflected by water level hydrographs is indicative of the change in ground water storage in phreatic zone with time. The ground water observation wells (GWOW) which are indicating a rise in water level trend, this may be due to local hydrological conditions prevailing in the area. Whereas hydrographs showing declining water level trend may be due to over-exploitation of ground water and these area require careful management of surface water and conjunctive use of surface water and ground water. Some of the hydrographs neither showing any substantial rise nor

major decline thus indicating that the dynamic storage of phreatic aquifer is being maintained which is being utilized before the monsoon and gets recharged post monsoon.

**Fig 1.2: Depth to water level map (Pre-monsoon, 2015)**




## 2.2.1 Ground Water Flow

The ground water table varies from 232.70m amsl in the south to 337.83m amsl in the north-western part of the district, thus indicating the major ground water flow towards the south central portion of the district i.e. towards Saha & Barara block.

## 2.2.2 Ground Water Quality

The distribution of chemical constituents in ground water as per ground water observation wells data 2015 is tabulated in annexure II. The ground water is alkaline in nature. The pH values range from 8.19 at Dhanura to 8.85 at Ambala cantt. It is moderately

to highly mineralized. The EC of ground water ranges from 425 μS/cm at Uplana to 2997 μS/cm at 25°C at Panjokhera. In most of the water samples, EC is below 2000μS/cm. The hardness value of ground water ranges from 51 mg/l at Pinjora to 480 mg/l at Panjokhera. Among cations, the concentration of calcium ranges between 8 mg/l at Mulana to 114 mg/l at Balana. Magnesium concentration ranges between 5 mg/l at Pinjora to 77 mg/l at Panjokhera. In majority of ground water samples, calcium and magnesium concentrations are less than 100 mg/l. The sodium content varies widely from 27mg/l at Uplana to 390 mg/l at Panjokhera whereas potassium content ranges from 0.5 mg/l at Ambala cantt. Race Course to 280 mg/l at Kakru. Among anions, bicarbonate is the dominant anion. Carbonate is found to be less in quantity and bicarbonate concentration ranges between 178 mg/l at Saha to 672 mg/l at Balana. The chloride concentration in ground water samples is within the desirable range of 250mg/l (BIS 1991) and it varies between 6.9 mg/l at Uplana to 347 mg/l at Panjokhera. The sulphate content in ground water ranges from 6 mg/l at Mullana to 418 mg/l at Panjokhera. The nitrate ($NO^3$) concentration ranges from trace to 250 mg/l at Panjokhera. The fluoride (F) content in ground water of the district is less than 1.0 mg/l and it ranges between 0.23 mg/l at Uplana to 0.93 mg/l at Pinjora.

Arsenic concentration of 0.058 mg/l has been found which is more than the permissible limit at site Balana in Ambala-II block. Iron concentration in ground water ranges from below detection limit to 8.428 mg/l at Dhanura. Ambala –I, Saha and Barara blocks have high iron concentration in ground water.

## 2.3 SPATIAL DATA DISTRIBUTION

The data of all the wells from PHED and Private in the area are plotted on the map of 1:50000 scale with 5'X5'grid (9 x 9km). Location of Public Health Engineering Department wells are given in Fig.2 and location of Private wells in Ambala district is given in Fig.3.

There are nine wells of Central Ground Water Board, 46 private wells and 534 wells are of Public Health Engineering Department.

The exploration data shows that majority of tube wells falls in the Ist Aquifer and IInd Aquifer. The grids/ formations devoid of SH/PZ/EW are identified as data gaps and these are to be filled by data generation.

**Fig 2: Location of PHED Wells**

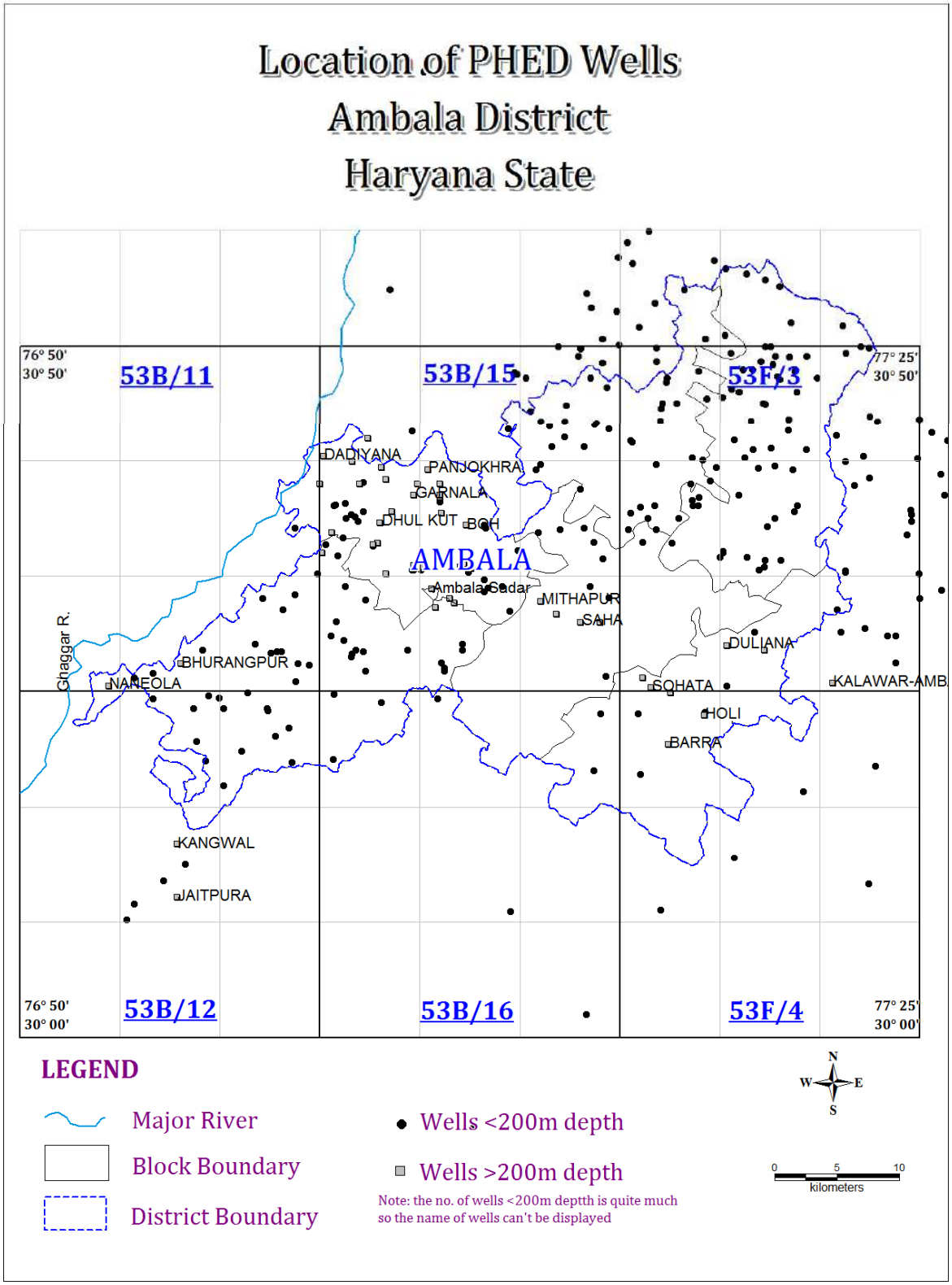
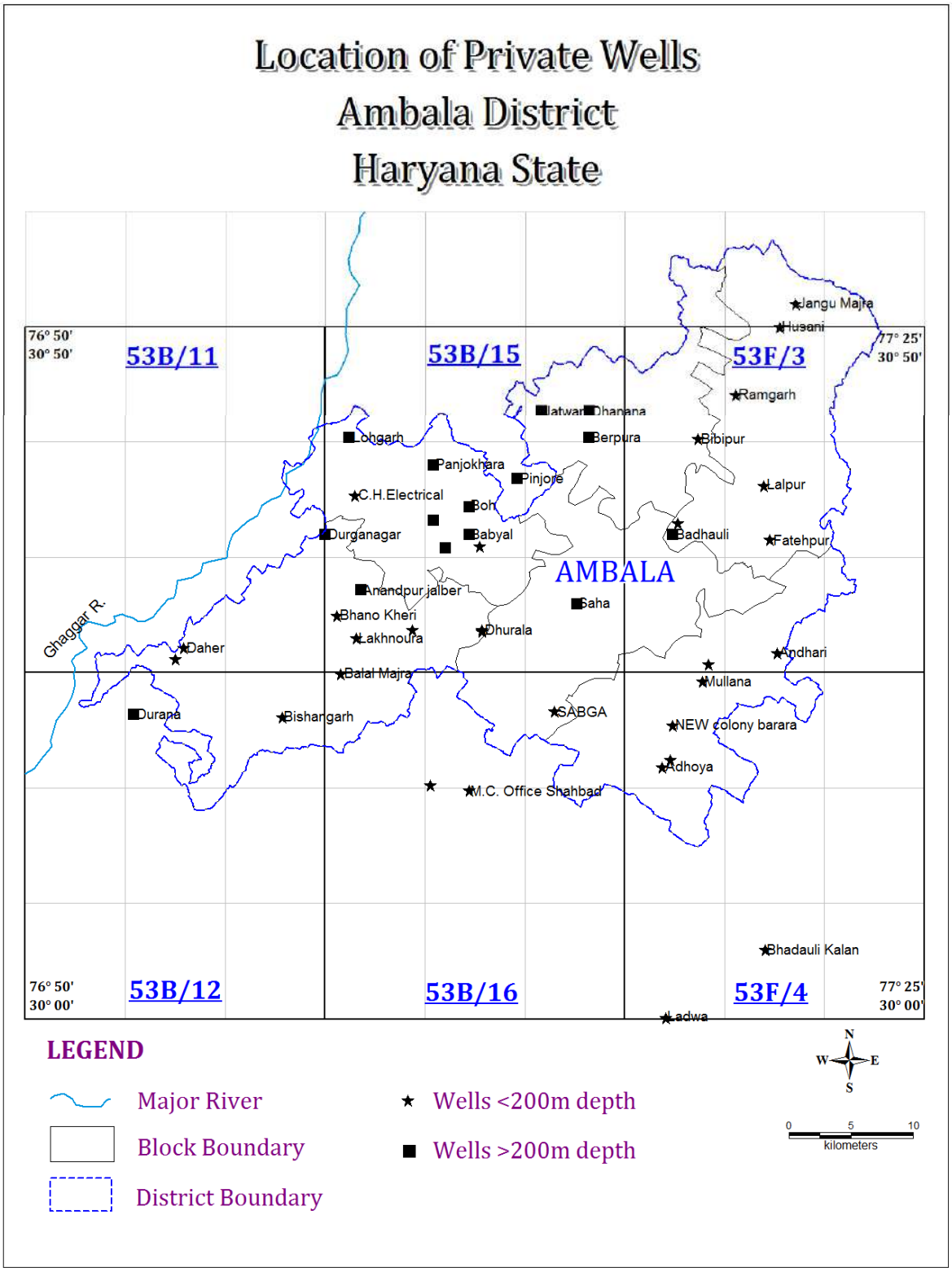


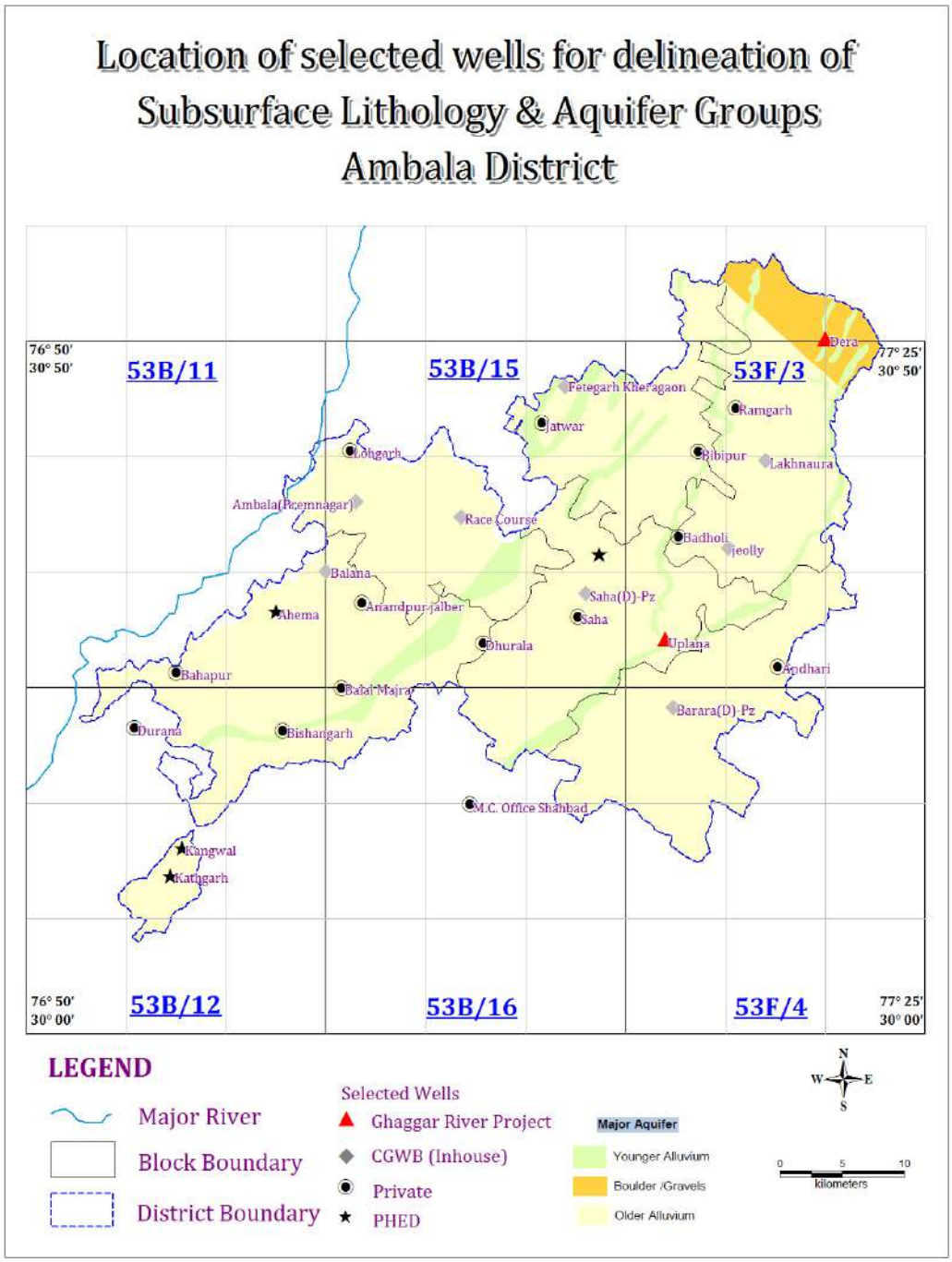
**Fig 3: Location of Private Wells**



## 2.4 DATA INTERPRETATION, INTEGRATION AND AQUIFER MAPPING

After considering all the available data, the deepest well in each quadrant is selected and plotted on the map of 1:50000 scale with 5'X5'grid (9 x 9km) and is shown in Fig 4.

**Fig 4: Validated Exploration Data of Ambala District**



The topography values has been plotted to prepare the elevation contour map and is shown in fig 5. The validated wells are plotted in and 3-D model and are shown in fig 6.

**Fig 5: Elevation Contour Map – Ambala District**

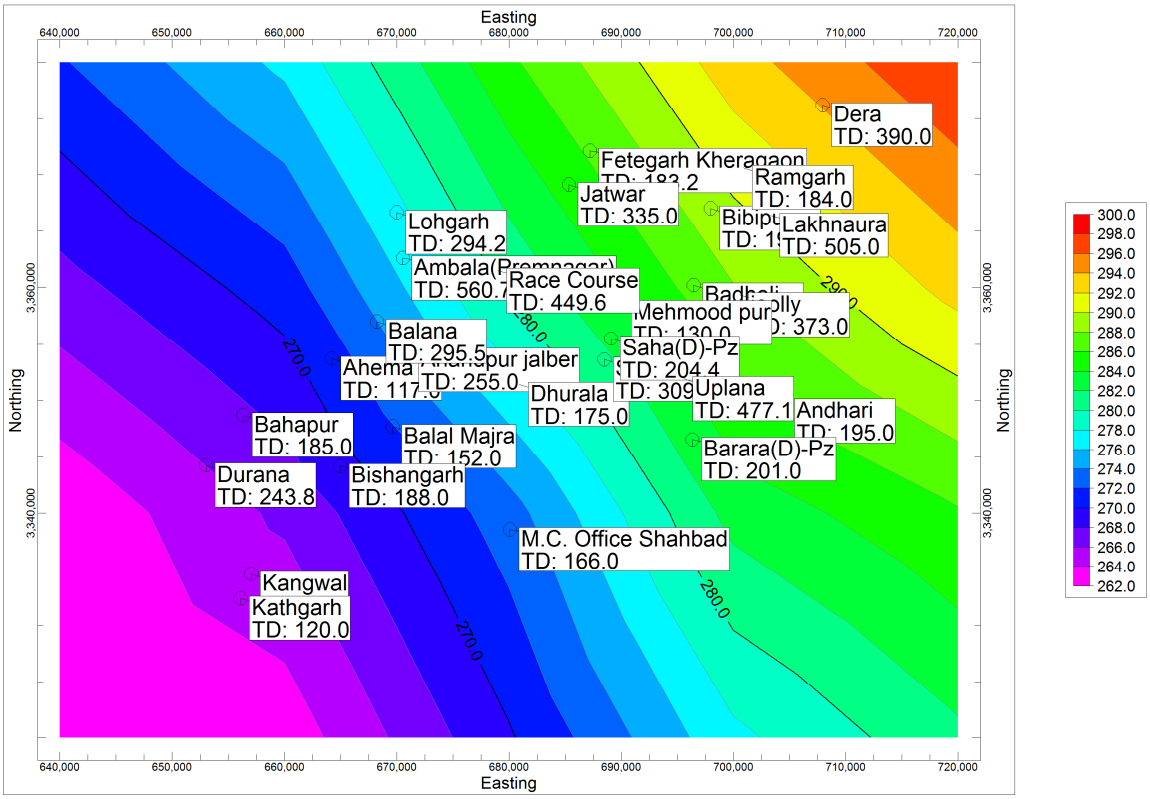
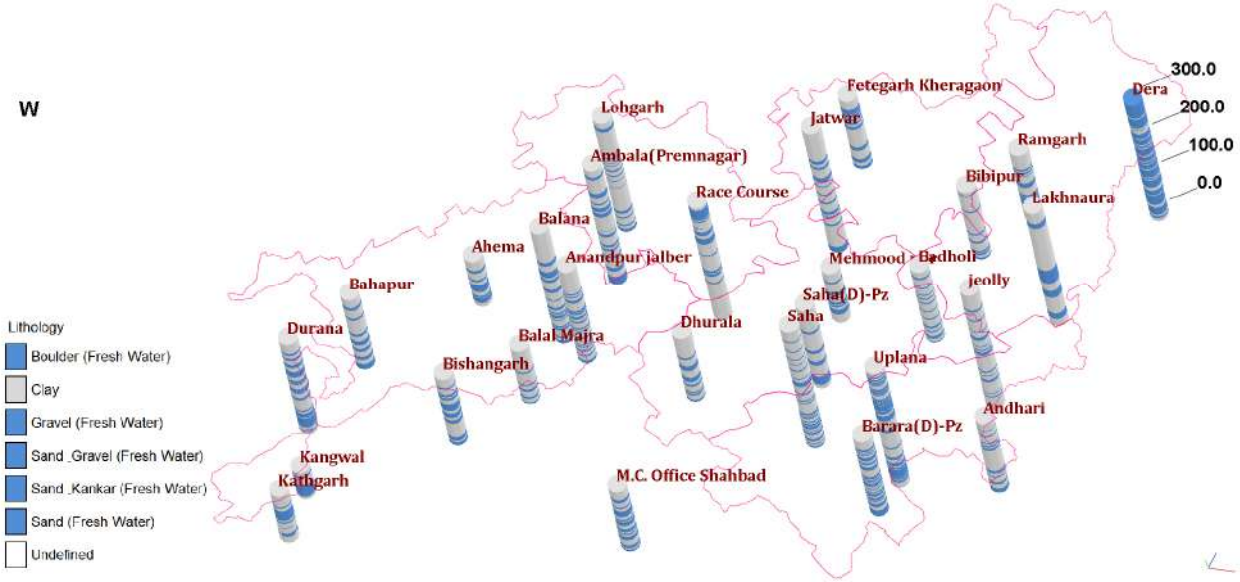



**Fig 6: 3Dimension location of validated Exploratory Wells with litholog**



Summarized details of the validated and optimized wells are given in table 2.

**Table 2: Summary of optimized exploration wells**

| District | Block | Toposheet | | Well Details & Depth | | | | Remarks |
|---|---|---|---|---|---|---|---|---|
| | | | | >300 | 200-300 | 100-200 | <100 | |
| Ambala | Shahjadpur | 53B/15 | 1C | 1 | - | 1 | - | Jatwar (335m) & Fetegarh Kheragaon (183.2m) |
| | | | 3B | - | - | - | - | - |
| | | 53F/3 | 1A | - | - | 1 | - | Bibipur (190m) |
| | | | 2A | - | - | 1 | - | Badholi (197m) |
| | Narain garh | 53F/3 | 1B | - | - | 1 | - | Ramgarh (184m) |
| | | | 2B | 2 | - | - | - | Jeolly (373m) & Lakhnaura (505m) |
| | | | 1C | 1 | - | - | - | Dera (390m) |
| | Ambala I | 53B/15 | 1A | - | 1 | - | - | Lohgarh (294.2m) |
| | | | 2A | 1 | - | - | - | Ambala(Premnagar)-(560.7m) |
| | | | 2B | 1 | - | - | - | Race Course (449.55m) |
| | Ambala II | 53B/11 | 3A | - | - | 1 | - | Bahapur (185m) |
| | | | 3B | - | 1 | - | - | Balana (295.5m) |
| | | | 3C | - | - | 1 | - | Ahema (117m) |
| | | 53B/12 | 1B | - | 1 | - | - | Durana (243.8m) |
| | | | 1C | - | - | 1 | - | Bishangarh (188m) |
| | | | 2B | - | - | 1 | 1 | Kangwal (70m) & Kathgarh (120m) |
| | | 53B/15 | 1C | - | 1 | - | - | Anandpur jalber (255m) |
| | | | 2C | - | - | 1 | - | Dhurala (175m) |
| | | 53B/16 | 1A | - | - | 1 | - | Balal Majra (152m) |
| | Saha | 53B/15 | 3B | - | - | - | - | Mehmoodpur (130m) |
| | | | 3C | 1 | 1 | - | - | Saha (309.45m) & Saha(D)-Pz (204.45m) |
| | | 53B/16 | 1B | - | - | 1 | | M.C. Office Shahbad (166m) |
| | | 53F/3 | 3A | 1 | - | - | - | Uplana (477.13m) |
| | Barara | 53B/16 | 2C | - | - | - | - | - |
| | | 53F/3 | 3C | - | - | 1 | - | Andhari (195m) |
| | | 53F/4 | 1A | - | - | 1 | - | Barara(D)-Pz (201m) |

# 3. HYDROGEOLOGY

## 3.1 PREVIOUS WORK

The Central Ground Water Board has drilled 20 exploratory borehole, 3 slim holes, and 13 piezometers to delineate and determine potential aquifer zones, evaluation of aquifer characteristics etc. Surveys conducted in the area reveal that alluvial thickness in the district is large and thickness of alluvium thins down towards southwest. In south west and western parts of the district the sediments are fine grained in nature, and constituted of fine to medium grained sands, clays, silts and kankars with occasional gravel. The clays are usually brown to yellowish in colour and sticky to silty in nature. The sands are usually fine grained; hence it becomes difficult to develop wells so as to give sand free water with conventional well designs. Towards east and south eastern part of the district the clays are cream or light grey coloured and are soft and silty. The sands are also mostly medium to coarse grained in nature in comparison to the fine texture of sands in south western and western part of the district.

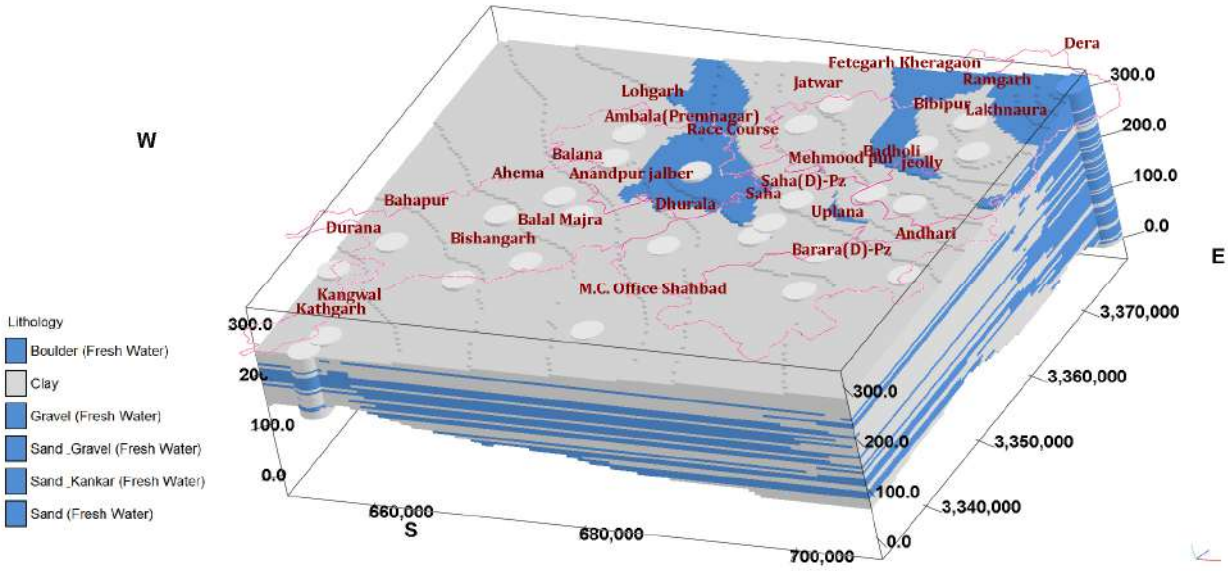
The ground water exploration revealed the presence of multiple aquifer groups down to a depth of 450 m. comprising fine to medium grained sand, clay, silt, and kankar with occasional gravel. The formation in general is fine grained in nature. The first granular zone forms the water table aquifer and occurs upto 167 m depth and is underlain by 10 to 15 m thick clay bed. The second aquifer occurs at a depth ranging between 65 to 294 m with varying thickness of 26 to 152 m. This aquifer constitutes comparatively less coarse material than the first group and is characterised by presence of Kankar. The third one is characterised by fine sandy beds alternating with thick clay beds at a depth ranging from 197 to 385 m exist between 180 and 205 m depth. The fourth aquifer occurs below 212 m onwards. Shallow tubewells are generally constructed upto a depth of 40 m. The discharge of shallow tubewells ranges 100 to 600 litres per minutes for a moderate drawdown. Deep tubewells constructed to a depth of 150 m yield upto 2000 to 3000 litres per minutes for 6 m to 10 m drawdown. However deeper tubewells tapping aquifer zones between150 m to 400 m depth, discharge ranges from 248 to 3293 LPM for a drawdown ranging from 2.84 to 12.93 m. Transmissivity values ranges from 154 to 4900 m2/day, Storativity 1.39x10-4 to $1.01x10^{-1}$. In general hydraulic conductivity values of aquifer zones decreases with depth,

with in 150 m depth it is around 10 m/day and for deeper horizons between 150 m to 400 m was around 6 m/day.

## 3.2 Present NAQUIM study

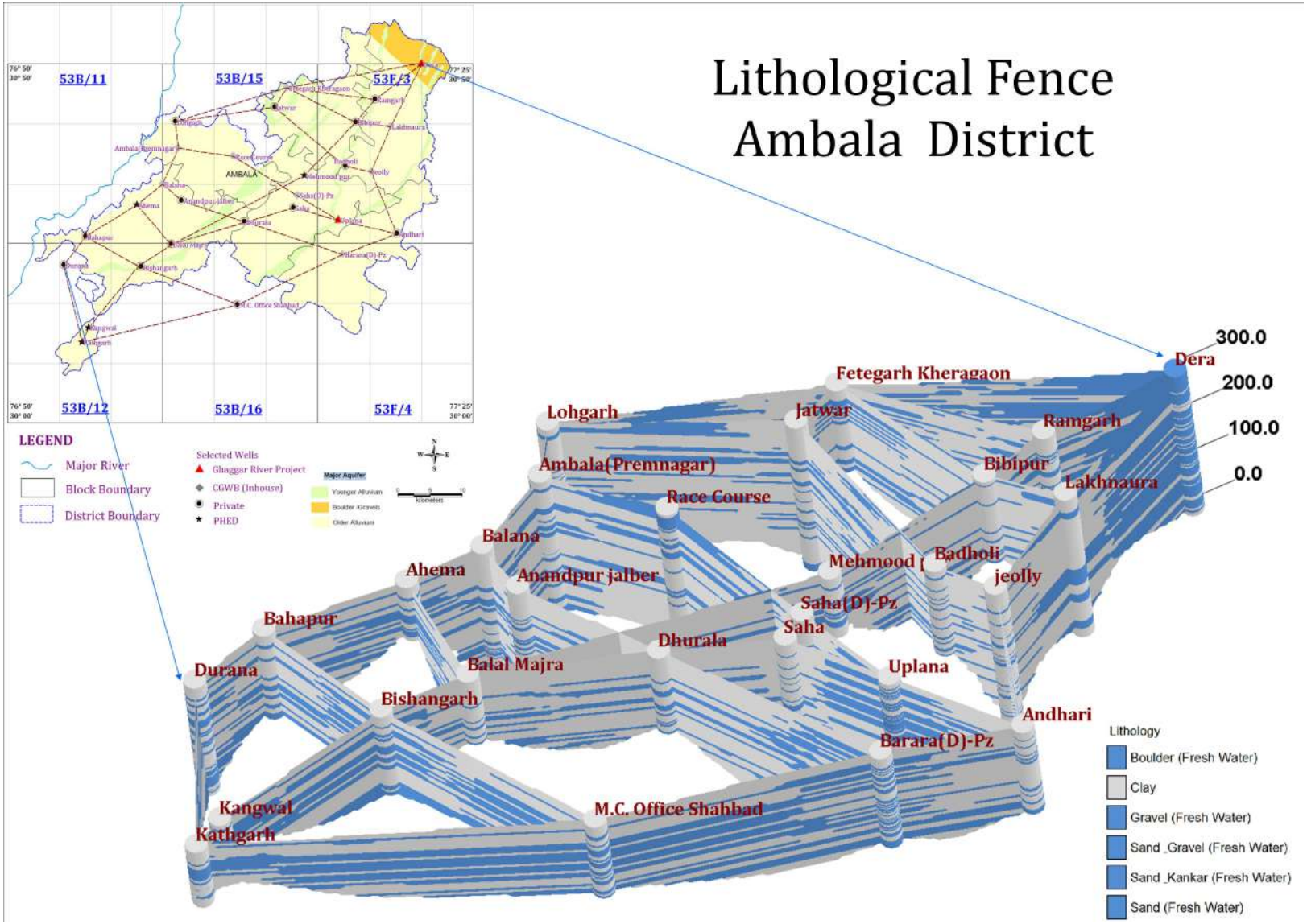
To understand the sub surface lithology and its disposition, the lithological data of the optimized wells drilled by CGWB, PHED and Private Agencies is plotted using the RockWorks15 software and a lithological model has been prepared and is shown in fig 7. The 3D lithological fence diagram has been prepared using the lithology model and is shown in fig 8.

**Fig 7: 3Dimension Lithological Model of Ambala District**




According to the major aquifer system found in the Ambala district shows that only in small part of the district at north is having boulder and gravel aquifer system at site Dera. The zones of boulder and gravel mixed with sand are interbedded with clay layers at site Dera. The top surface layer is basically surface soil which is silty clay. The rest part of the district falls under the Alluvium aquifer system which is mainly sand, silt and clay. The sand is inter-layered with clay and clay thickness decreases from north to south. The clay dominates over sand in the whole district. Thick layers of clay occur at site Race Course (Ambala cantt.) and the maximum thickness of clay is 172m. The maximum thickness of sand is 82m at site Ambala (Premnagar). All the observations are more clearer in the 3D lithological fence diagram.

**Fig 8: 3Dimension Lithological Fence of Ambala District**



## 3.3 Aquifer Geometry

Ambala District falls under the Ghaggar River Basin, with thin interlayering of sand and clay beds. Based on the exploration data, the area can be divided into 2-3 aquifer system. To know the broad picture of the aquifer disposition, inter-relationship of granular zones, nature, geometry and extension of aquifers in the Ambala district, the aquifer grouping has been done using the sub-surface lithology and a three-dimensional aquifer model has been prepared (Fig 9). The 2D aquifer map was also prepared using the aquifer model and is shown in Fig 10. The aquifer grouping is done and given in Table 3. The first aquifer is water table aquifer and extends all over the area. The aquifer is mainly composed of fine to coarse grained sand.

**Table 3: Aquifer Grouping in Ambala District**

| Aquifer Group | Average Range (m bgl) | | Thickness (m) | |
|---|---|---|---|---|
| | From | To | Min | Max |
| Aquifer I | 6 | 145 | 127 | 153 |
| Aquifer II | 204 | 258 | 22 | 51 |
| Aquifer III | 257 | 297 | 28 | 45 |

* the aquifer group II at Saha ranges from 28 to 305

**Fig 9: 3-Dimension Aquifer Model – Ambala District**

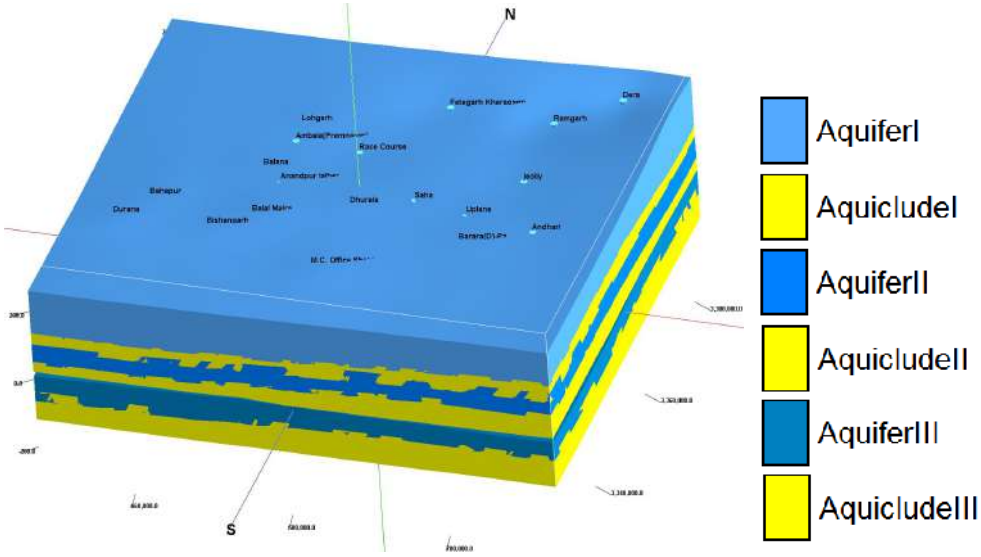
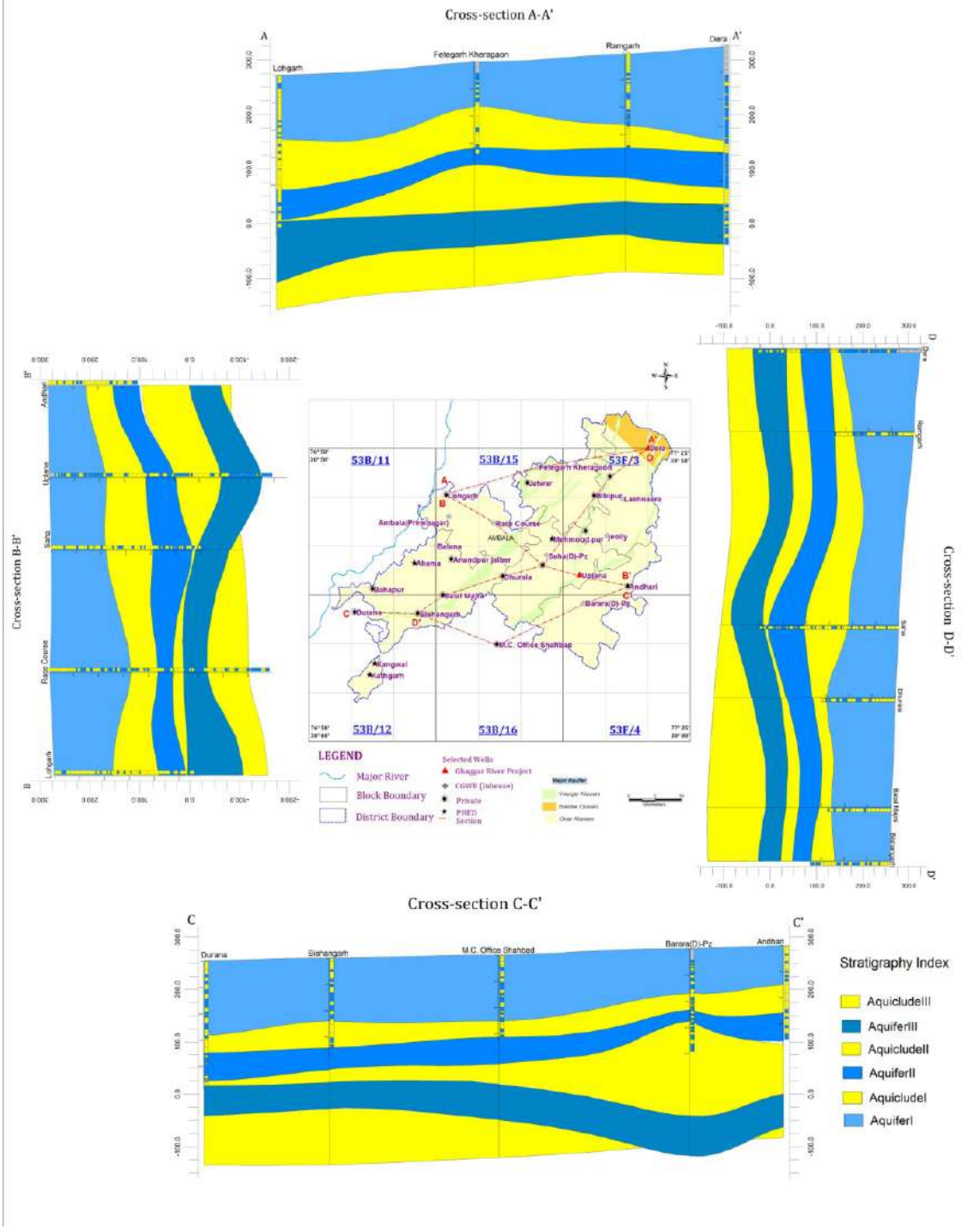



**Fig 10: Cross sections of Aquifer - Ambala District**

# Aquifer Map
# Ambala District



# 4. GROUND WATER RESOURCES

Ground water resource estimation of the area have been carried out by taking Dynamic and Static/In-storage resources of unconfined aquifer and confined aquifers present upto 300m depth. The assessment of dynamic ground water Resources of the study area have been carried out jointly by CGWB and Ground Water Cell, Department of Agriculture, Haryana on the basis of Ground Water Estimation Committee (1997) methodology based on data available and as per the revised methodology for the year as on 31st March 2013.

The occurrence of potential aquifers (productive granular zones) upto 300 m depth has been demarcated on basis of aquifer wise subsurface mapping. The total saturated thickness of granular zones was derived from the exploratory borehole data of a particular block. The granular zones occurring below the zone of water level fluctuation up to the first confining layer has been considered as static unconfined zone. The ground water resource of this zone has been calculated considering 12% specific yield of the formation. The specific yield value for the unconfined aquifer has been taken as 60% of 0.12 which comes as 0.072 whereas for the confined aquifer, the storativity value has been considered. Since the specific yield is likely to reduce with increase in depth due to compaction of overlying sediments.

Hence, the major data elements considered in this estimation are thickness of granular zones, specific yield/storativity, and area of both fresh water and saline/brackish water. It has been observed that in some of the blocks sufficient data on probable occurrence of granular zones was not available. In those cases, the existing exploratory data of adjoining block/district has been either extrapolated or interpolated to derive such parameters required for estimation. This assessment of total groundwater resources has been computed based on the available data with CGWB & Ground Water Cell, Department of Agriculture, Haryana.

## 4.1 Unconfined aquifers

**Dynamic Resources**

The stage of ground water development ranges between 80% (block-Ambala I) to 130% (block- Saha). Net ground water availability in the district is 56306 ham. Existing ground

water draft for all uses is 57466 ham. Net ground water availability for future irrigation development is 1675 ham. The stage of ground water development in the district is 102%.

**Table 4: Dynamic Ground Water Resource & Development Potential (as on 31.03.13)**

| Assessment Unit/ Block | Net Annual Ground Water Availability | Existing Gross Ground Water Draft for irrigation | Existing Gross Ground Water Draft for domestic and industrial water supply | Existing Gross Ground Water Draft for All uses | Provision for domestic, and industrial requirement supply to 2025 | Net Ground Water Availability for future irrigation development (10-11-14) | Stage of Ground Water Development {(13/10) * 100} (%) |
|---|---|---|---|---|---|---|---|
| Ambala I | **14072** | 10018 | 1305 | 11323 | 522 | 3532 | 80 |
| Ambala II | **7408** | 5593 | 1170 | 6763 | 193 | 1622 | 91 |
| Barara | **7780** | 8637 | 1320 | 9957 | 1320 | -2177 | 128 |
| Naraingarh | **10392** | 10929 | 1620 | 12549 | 1620 | -2156 | 121 |
| Shazadpur | **9224** | 6007 | 1215 | 7222 | 140 | 3077 | 78 |
| Saha | **7429** | 8572 | 1080 | 9652 | 1080 | -2223 | 130 |
| **TOTAL** | **56306** | **49756** | **7710** | **57466** | **4875** | **1675** | **102** |

**In storage Ground Water Resources**

As per revised guidelines recommended by the Central Level Expert Group on ground water resources assessment, the resources are separately considered as dynamic and in-storage unconfined. In case of alluvial area, the in-storage resources of unconfined aquifer have been computed based on specific yield of the aquifer as detailed below:

In-storage Ground Water resources (unconfined Aquifer) = Thickness of the aquifer (granular/productive zone) below the zone of water level fluctuation down to the bottom layer of unconfined aquifer x Sp. Yield of the aquifer x Areal extent of the aquifer

**4.2 Confined Aquifer**

The availability of ground water resources in confined aquifer have two components: Storage under pressure (using Storativity concept) and Storage under de-saturated (gravity drainage) condition (using Specific Yield concept) (source: Assessment

of Ground Water Resources; A Review of International Practices, 2014) and is shown in Fig 11. However, since ground water withdrawals from confined aquifer are known to have serious environmental degradation effects, the preliminary assessment of ground water resources in confined aquifer is restricted to the estimation of ground water storage under pressure conditions only but here the storage under de-saturation is also computed.

**Storativity Concept:**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ii) | In-storage Ground Water resources (within the Peizometer) | = | Thickness of the water column in Peizometer of particular confined aquifer up to the top layer of same confined aquifer | × | Storativity of the confined aquifer | × | Areal extent of the confined aquifer group |

**Specific Yield Concept:**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| ii) | In-storage Ground Water resources (within the aquifer thickness) | = | Thickness of the confined aquifer (granular/ productive zone) down to the bottom layer of confined aquifer or exploitable depth of 300 m | × | Sp. Yield of the aquifer | × | Areal extent of the confined aquifer group |

Preliminary assessment of the ground water resources in confined aquifer does not imply that the assessed resource is available for exploitation. The objective of this exercise is to have an overview of the ground water regime in the particular confined aquifer. It should be kept in mind that any significant ground water withdrawal from confined aquifer may invoke serious environmental degradation problem. Therefore, in case the preliminary assessment reveals that ground water is being withdrawn in significant quantity for any confined aquifer, that particular aquifer should be identified for detailed assessment using numerical modelling approach.

***Total Availability of Ground Water Resources = Dynamic Resources + In-storage Resources.***

**Fig 11: Concept for Resource Estimation in Unconfined and Confined Aquifer System**

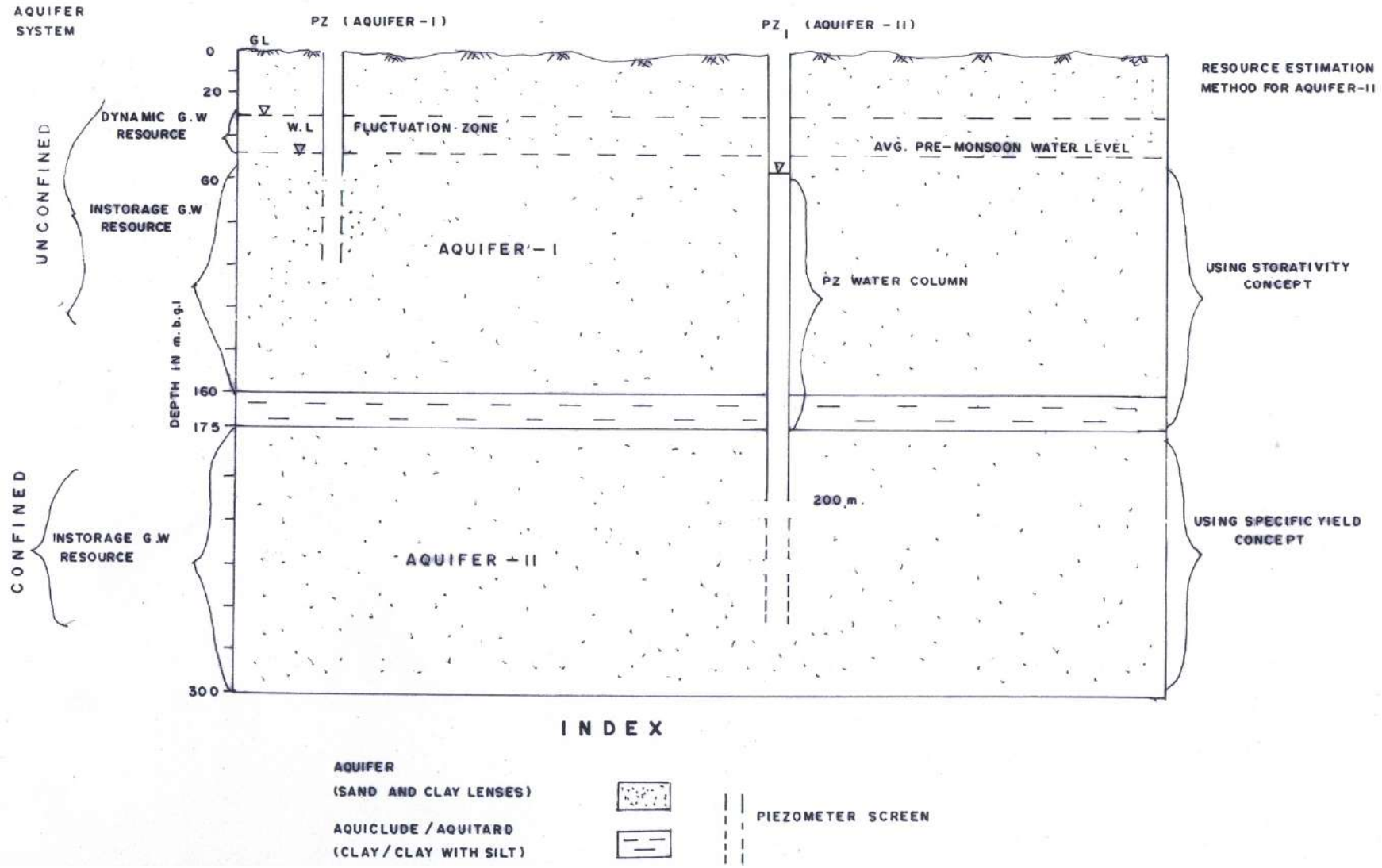


**TABLE 5: BLOCK WISE INSTORAGE GROUND WATER RESOURCES IN UNCONFINED AQUIFER-I**

| Sr. No. | Name of Assessment Unit | Type of rock formation | Areal extent (ha) | | | | Average Pre-monsoon Water Level (m bgl) | Depth to bottom of unconfined aquifer I (m bgl) | Total Thickness of formation below Pre-monsoon Water Level (m) (9-8) | Thickness of the Granular Zone in unconfined aquifer I below Pre-monsoon WL (m) | Average Specific Yield | In-Storage Ground Water Resources [(6)*(11)*(12)*] FRESH (ham) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Total Geographical Area | Assessment Area | | | | | | | | |
| | | | | Total | Fresh Water | Brackish/Saline Water | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 1 | Ambala I | Alluvium | 39697 | 39697 | 39697 | 0 | 4.68 | 144 | 139.32 | 42 | 0.072 | 120044 |
| 2 | Ambala II | | 14700 | 14700 | 14700 | 0 | 4.39 | 140 | 135.61 | 47 | 0.072 | 49745 |
| 3 | Barara | | 25650 | 25650 | 25650 | 0 | 6.3 | 146 | 139.7 | 64 | 0.072 | 118195 |
| 4 | Naraingarh | | 27071 | 26771 | 26771 | 0 | 14.19 | 166 | 151.81 | 70 | 0.072 | 134926 |
| 5 | Shazadpur | | 28500 | 28500 | 28500 | 0 | 14 | 143 | 129 | 44 | 0.072 | 90288 |
| 6 | Saha | | 23967 | 23967 | 23967 | 0 | 3.7 | 130 | 126.3 | 46.4 | 0.072 | 80069 |
| **Dist. Total (ham)** | | | **159585** | **159285** | **159285** | **0** | | | | | | **593267** |
| **Dist. Total (bcm)** | | | | | | | | | | | | **5.933** |

## TABLE 6: BLOCK WISE INSTORAGE GROUND WATER RESOURCES - CONFINED (AQUIFER II)

| Sr. No. | Name of Assessment Unit | Type of rock formation | Areal extent (ha) | | | | Top Unconfined Aquifer II (mbgl) | Water Column in Piezometer | Bottom of Confined Aquifer II (mbgl) | Total Thickness of confined aquifer II (m) (9-8) | Thickness of the Granular Zone in confined aquifer II (m) | Average Specific Yield (Unconfined Aquifer) | Average value of Storativity (Confined Aquifer) | In-Storage Ground Water Resources within Peizometer of Aquifer II (Storativity Concept)[(6)*(10)*(15)*]FRESH (ham) | In-Storage Ground Water Resources Within Aquifer Thickness (Specifice Yield Concept)[(6)*(13)*(14)*]FRESH (ham) | Total In-Storage Ground Water Resources (Aquifer II) [(16)+(17)] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Total Geographical Area | Assessment Area | | | | | | | | | | | | |
| | | | | Total | Fresh Water | Brackish/ Saline Water | | | | | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 1 | Ambala I | Alluvium | 39697 | 39697 | 39697 | 0 | 184 | 147 | 243 | 59 | 28 | 0.072 | 0.00139 | 8111 | 80029 | 88140 |
| 2 | Ambala II | | 14700 | 14700 | 14700 | 0 | 186 | 149 | 256 | 70 | 34 | 0.072 | 0.00139 | 3045 | 35986 | 39030 |
| 3 | Barara | | 25650 | 25650 | 25650 | 0 | 220 | 183 | 287 | 67 | 51 | 0.072 | 0.00139 | 6525 | 94187 | 100711 |
| 4 | Naraingarh | | 27071 | 26771 | 26771 | 0 | 211 | 174 | 239 | 28 | 22 | 0.072 | 0.00139 | 6475 | 42405 | 48880 |
| 5 | Shazadpur | | 28500 | 28500 | 28500 | 0 | 207 | 170 | 244 | 37 | 22 | 0.072 | 0.00139 | 6735 | 45144 | 51879 |
| 6 | Saha | | 23967 | 23967 | 23967 | 0 | 217.5 | 180.5 | 279 | 61.5 | 43 | 0.072 | 0.00139 | 6013 | 73339 | 79352 |
| **Dist. Total (ham)** | | | **159585** | **159285** | **159285** | **0** | | | | | | | | **36903** | **371090** | **407993** |
| **Dist. Total (bcm)** | | | | | | | | | | | | | | **0.369** | **3.711** | **4.080** |

The average peizometer head of aquifer II is 37m bgl.

**TABLE 7: BLOCK WISE INSTORAGE GROUND WATER RESOURCES - CONFINED (AQUIFER III-upto300m depth)**

| Sr. No. | Name of Assessment Unit | Type of rock formation | Areal extent (ha) | | | | Top of Confined Aquifer III (m bgl) | Bottom of Confined Aquifer III (m bgl) | Total Thickness of confined aquifer III (m) (9-8) | Thickness of the Granular Zone in confined aquifer III (m) | Average Specific Yield (Unconfined Aquifer) | In-Storage Ground Water Resources Within Aquifer Thickness (Specifice Yield Concept)[(6)*(11)*(12)*]FRESH (ham) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Total Geographical Area | Assessment Area | | | | | | | | |
| | | | | Total | Fresh Water | Brackish/Saline Water | | | | | | |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| | **Ambala** | | | | | | | | | | | |
| 1 | Ambala I | Alluvium | 39697 | 39697 | 39697 | 0 | 255 | 300 | 45 | 31 | 0.072 | 88604 |
| 2 | Ambala II | | 14700 | 14700 | 14700 | 0 | 255 | 300 | 45 | 31 | 0.072 | 32810 |
| 3 | Barara | | 25650 | 25650 | 25650 | 0 | - | - | - | - | - | - |
| 4 | Naraingarh | | 27071 | 26771 | 26771 | 0 | 262 | 290 | 28 | 11 | 0.072 | 21203 |
| 5 | Shazadpur | | 28500 | 28500 | 28500 | 0 | - | - | - | - | - | - |
| 6 | Saha | | 23967 | 23967 | 23967 | 0 | - | - | - | - | - | - |
| | **Dist. Total (ham)** | | **159585** | **159285** | **159285** | **0** | | | | | | **142617** |
| | **Dist. Total (bcm)** | | | | | | | | | | | **1.426** |

The Peizometer head value for confined Aquifer III is not available or it is not tapped yet, therefore, resources within the aquifer thickness are estimated only

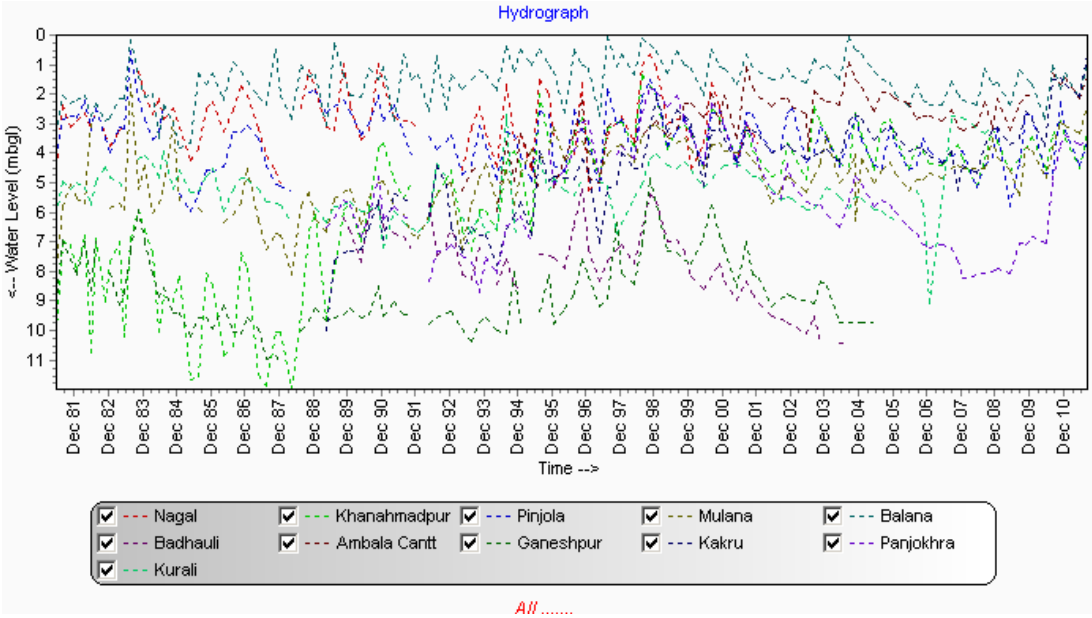
**TABLE 8: BLOCK WISE TOTAL AVAILABLE GROUND WATER RESOURCES IN AQUIFERS UP TO 300m DEPTH**

| Block | Type of Rock Formation | Total Geographical Area (ha) | Total Assessment Area (Ha) | Net Ground Water Availability (Dynamic Ground Water Resources) (As on 31st March 2011) (in ham) | Fresh In-Storage Ground Water Resources (Aquifer I)(in ham) | Total Groundwater Resources Aquifer-I(in ham) | Fresh In-Storage Ground Water Resources (Aquifer II)(in ham) | Fresh In-Storage Ground Water Resources (Aquifer III)(in ham) | Total Availability of Ground Water Resources upto 300m (in ham) | Total Availability of Ground Water Resources upto 300m (in bcm) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 2 | 5=(1+2) | 3 | 4 | 6=(5+3+4) | 7 |
| | | | | | Based on Aquifer Mapping | | | | | |
| Ambala I | Alluvium | 39697 | 39697 | 14072 | 120044 | 134116 | 88140 | 88604 | 310860 | 3.109 |
| Ambala II | | 14700 | 14700 | 7408 | 49745 | 57153 | 39030 | 32810 | 128993 | 1.290 |
| Barara | | 25650 | 25650 | 7780 | 118195 | 125975 | 100711 | - | 226687 | 2.267 |
| Naraingarh | | 27071 | 27071 | 10392 | 134926 | 145318 | 48880 | 21203 | 215401 | 2.154 |
| Shazadpur | | 28500 | 28500 | 9224 | 90288 | 99512 | 51879 | - | 151391 | 1.514 |
| Saha | | 23967 | 23967 | 7429 | 80069 | 87498 | 79352 | - | 166850 | 1.669 |
| **Dist. Total (ham)** | | 159585 | 159585 | **56306** | **593267** | **649573** | **407993** | **142617** | **1200182** | **12.002** |
| **Dist. Total (bcm)** | | | | **0.563** | **5.933** | **6.496** | **4.080** | **1.426** | **12.002** | |

## 5. GROUND WATER RELATED ISSUES

The quality of ground water is not an issue in the district and is potable for both the drinking as well as irrigation purposes. In some parts of the district i.e. Saha, Barara and Naraingarh blocks; the ground water extraction is high as compared to the overall recharge of it. The ground water extraction is mainly for irrigation purposes and it will lead to decline in water level which can be observed by plotting the hydrographs at different part of the district. Due to over-exploitation of ground water, these three blocks has been categorized as Over-Exploited according to the Dynamic Ground Water Resource Assessment (2013).

**Fig: 12: Long term ground water level variation.**




### 5.1 GROUND WATER IRRIGATION SCENARIO

As per the data available from minor irrigation census 2006-07 the detailed number of shallow, deep, tube wells, lined, unlined water distribution system are given below in table 9 and 10. Number of irrigation tubewells as per depth range is given in Fig.13.

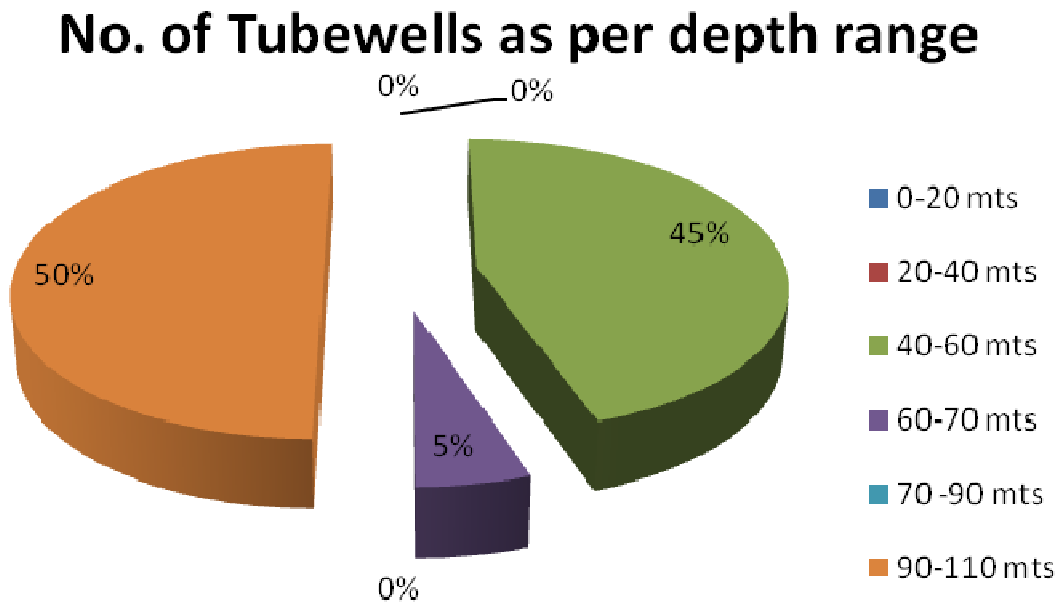
**Table 9: Distribution of Tube wells According to Owner's Holding Size**

| Marginal (0-1 ha) | Small (1-2 ha) | Semi-Medium (2-4 ha) | Medium (4-10ha) | Public | Group of Farmers | Total |
|---|---|---|---|---|---|---|
| **124** | **980** | **3931** | **2144** | **1626** | **10236** | **19041** |

**Table 10: Type of Ground water distribution device**

| Open Water Channel | | |
|---|---|---|
| Lined/pucca | Unlined/kutcha | Total |
| **14014** | **5027** | **19041** |

**Fig 13: Irrigation tubewells as per depth range.**




## 6. AQUIFER MANAGEMENT PLAN

An outline of the Aquifer Management Plan for each block is given in chapter-7. This includes details regarding population, rainfall, average annual rainfall, agriculture and irrigation, water bodies, ground water resource availability, ground water extraction and water level behavior. Aquifer disposition and various cross sections have also been given. Ground water resources, extraction and other issues including ground water resource enhancement and demand side innervations have been given.

Another focus has been given to minimize the gross draft by enhancing ground water use efficiency in irrigation system after replacing the water distribution system from unlined/kutcha channel to Under Ground Pipeline System (UGPS) in over exploited blocks of the district.

## 6.1 SCOPE OF IMPLEMENTATION

This plan is focusing on the technical aspects of the ground water recharge through various means so that various implementing agencies may get the appropriate technical guidelines. The existing/ongoing schemes of the central or state govt. like MANERGA, IWSP, PMKSY (Prime Minister Krishi Sinchai Yojna), NABARD funded schemes, Urban Development schemes, departmentally funded projects etc. may be benefitted from the recharge plan by incorporating the input in the operational guidelines/ design and for locating the specific sites.

Agriculture University, Engineering Collages, Academic and Research Institution, NGO may also take up the pilot or demonstrative projects in the blocks suitable to them to plan at local level as per local conditions.

Scope of quantitative impact on stage of development after applying various management strategies is given in Table 11.

## 6.2 POTENTIAL OF ENHANCING THE GROUND WATER USE EFFICIENCY

The micro level transformation in the ground water management have vast impact potential to counter extensive ground water depletion faced in the state of Haryana, particularly in overexploited blocks.

There are around 5027 (out of 19041) tubewells (26.40%) operated by farmers for irrigation through unlined/Katcha open channel system in Ambala district where water from the tubewell is discharge to the agricultural field. In this process, huge (upto 25%) quantity of ground water is wasted in soil moisture and evaporation losses.

Around 76% of the tube wells are of in depth range of upto 70 meters and remaining are deeper (70-110 m) depth in the district. Thus majority of wells are tapping Aquifer group-I which is under stress due to overexploitation.

Dynamic ground water resources (2013) indicate that Gross ground water draft for irrigation in Ambala district is estimated at 497.56 MCM. It is expected that around 25% of over draft can be brought down by switching over to underground/surface pipeline based distribution from the prevailing unlined open channels. Thereby gross draft will be reduced to the tune of 32.83 MCM assuming there is no crop diversification by the farmers.

The benefit will lead to saving of precious ground water resources in overexploited blocks. The measure if implemented will bring down the ground water overdraft from 102%

to 96%. The category of the blocks will also improve resulting in boosting of agriculture and industrial development otherwise not sustainable in over-exploited blocks.

The tube wells also consume enormous electricity which is subsidized and government incurs significant revenue on this account. The measures therefore will result in saving of energy and money. Pollution impact will be reduced whenever diesel engines are used by the farmers. The environmental and ecological condition in the irrigated land will improve. Unwanted weed growth will also be controlled inside the farm land. This will also be useful in the waterlogged/ shallow water table areas as the seepage losses in these areas also aggravate the water logging. **Government should make/launch a mission mode program for installing the underground pipe lines instead of having *katcha* channel in the entire Haryana**. Heavy ground water overdraft can be reduced by these efforts. This will ensure **more crops per drop**.

**6.3 WATER SAVING POTENTIAL FROM CROP DIVERSIFICATION – CHANGE PADDY TO MAIZE/SOYABEAN:**

As the requirement of water for paddy is much high therefore by changing paddy to maize/soyabean will help in saving of water. For estimating the water saving by crop diversification it is assumed that one mcm of water will be saved in case of maize or soyabean planted in one sq km of land. In case of pulses even higher amount of ground water can be saved.

**Table 11: Scope of Quantitative Impact on Stage of Development after applying various management strategies**

| Block | Net Ground Water Availability (mcm) | Total Draft (mcm) | Present Stage of draft (SOD) (%) As per 2013 | Reduction in draft by different water saving method | | | | SOD afterwards (%) | Change of paddy cultivation area (% of existing) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Replace water courses by UG Pipes (mcm) | Adopt Artificial recharge (mcm) | Change Paddy to Maize (mcm) | Total (mcm) (2+3+4) | | |
| | | | 1 | 2 | 3 | 4 | 5 | | |
| Ambala I | 140.7 | 113.2 | 80 | 6.6 | NA | NA | 6.6 | 76 | NA |
| Ambala II | 74.1 | 67.6 | 91 | 3.7 | NA | NA | 3.7 | 86 | NA |
| Barara | 77.8 | 99.6 | 128 | 5.7 | 0.2 | 15.9 | 21.8 | 100 | 8 |
| Naraingarh | 103.9 | 125.5 | 121 | 7.2 | 1.5 | 12.8 | 21.5 | 100 | 10 |
| Shazadpur | 92.2 | 72.2 | 78 | 4.0 | NA | NA | 4.0 | 74 | NA |
| Saha | 74.3 | 96.5 | 130 | 5.7 | 0.2 | 16.3 | 22.2 | 100 | 20 |
| **Total** | **563.1** | **574.7** | **102** | **32.8** | **1.9** | **45** | **79.8** | **88** | **38** |

# 7. BLOCK WISE AQUIFER MAPS AND MANAGEMENT PLAN

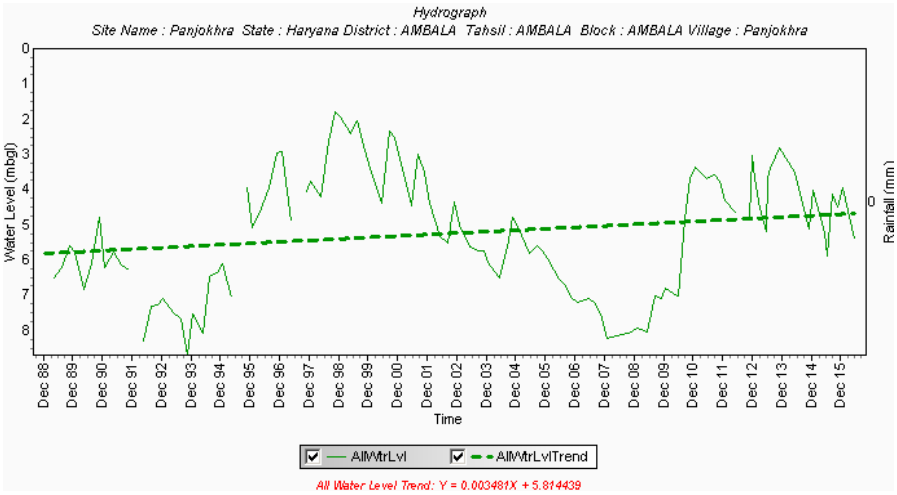
## i. AMBALA –I BLOCK (396.97 Sq. km.)

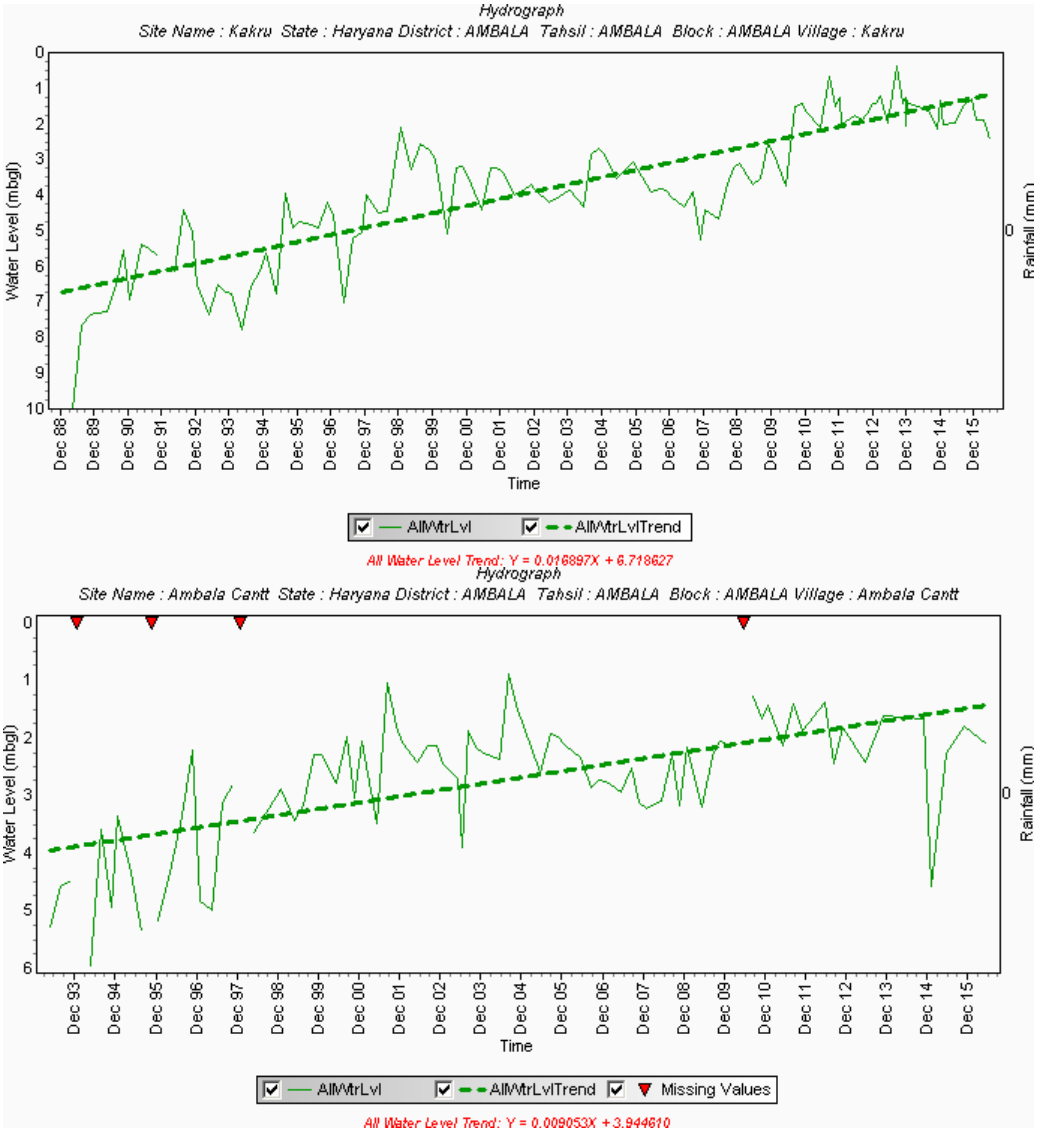
| | |
|---|---|
| **Population (2011)** | Rural-147420 |
| | Urban-6035 |
| | Total-153455 |
| **Rainfall** | Monsoon -440.60mm |
| | Non Monsoon-144.40mm |
| **Average Annual Rainfall** | 585mm |
| **Agriculture and Irrigation** | Major Crops- Rice, Wheat, Maize, Bajra |
| | Other crops-Barley, Pulses, Oilseeds, Sugarcane, potatoes, chillies |
| | Net Area Sown-310.39 sqkm |
| | Total Irrigated Area-302.71 sqkm |
| **Water Bodies** | 27 nos. |

**Ground Water Resource Availability**: Ground Water Resources available in the different group of aquifers. Aquifer I (141m) is very prominent in terms of thickness and geographic extent. Aquifer II (70m) & Aquifer III (45m) are less in thickness. Block is categorized as safe as per 2013 assessment.

**Ground water Extraction**: Information regarding the abstraction from Aquifer II is not available, but there are drinking water supply tapping combined aquifer and separate aquifer could not be assessed separately.

**Water level Behavior(2015):**Pre Monsoon-1.7-5.2mbgl & Post Monsoon-0.9-11.2mbgl



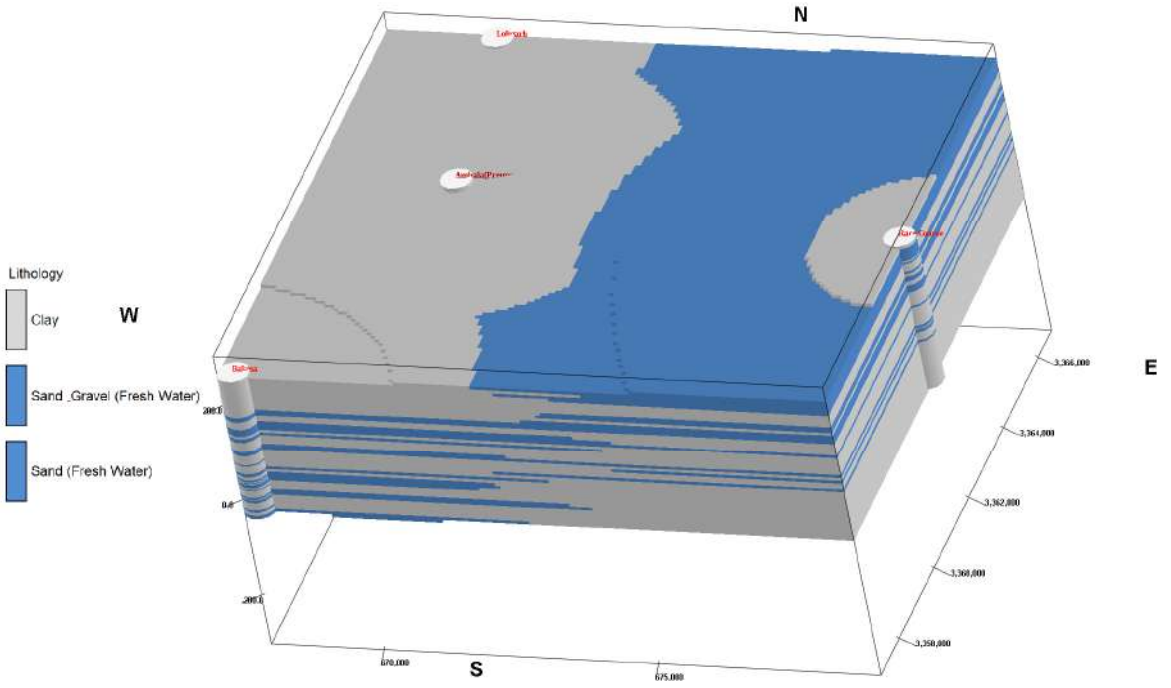



**Aquifer Disposition:** Multiple Aquifer System (3 Aquifer System)

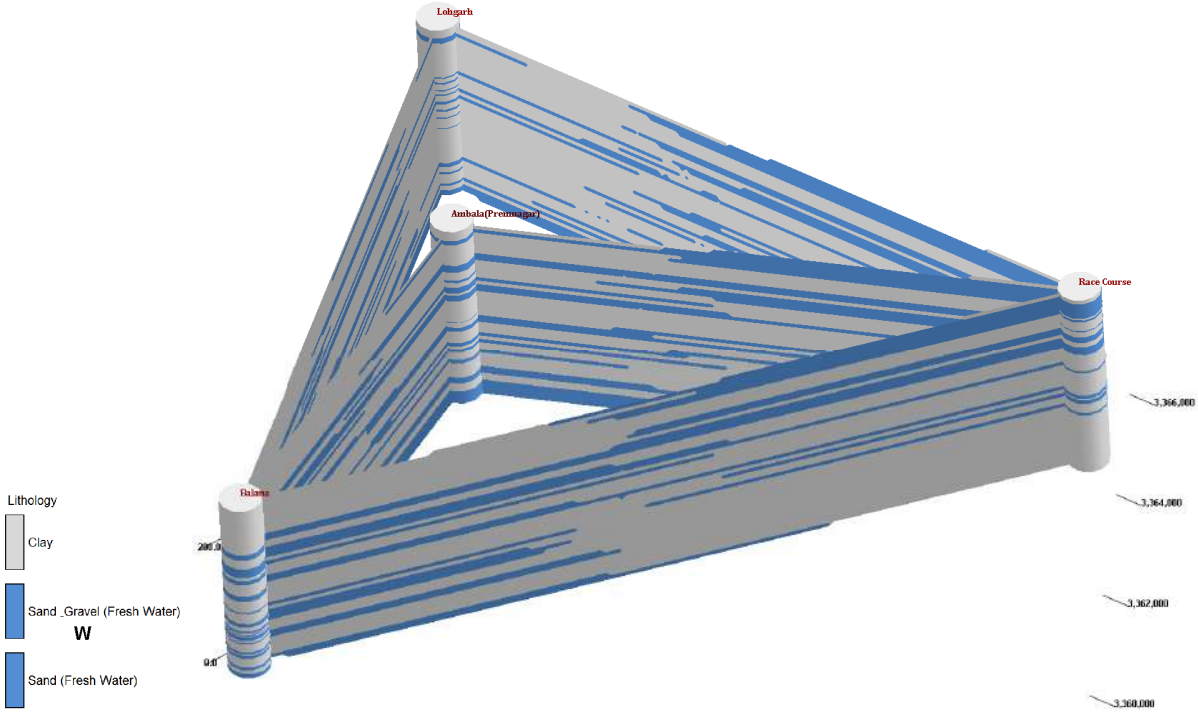
| Aquifer | Geology | Type of Aquifer | Thickness of Granular Zones (m) | Transmissivity ($m^2$/day) | Specific Yield % | Storativity |
|---|---|---|---|---|---|---|
| Aq-I (3-144m) | Quaternary Alluvial deposits | Unconfined | 42 | 146-1246 | 12 | NA |
| Aq-II (184-243m) | | Semi confined to Confined | 28 | - | NA | $1.39x10^{-3}$ |
| Aq-III (255-300m) | | Semi confined to Confined | 31 | - | NA | $1.39x10^{-3}$ |

Aquifer comprises of freshwater only and the main aquifer formations are gravel and sand. The non-aquifer material comprise of clay.

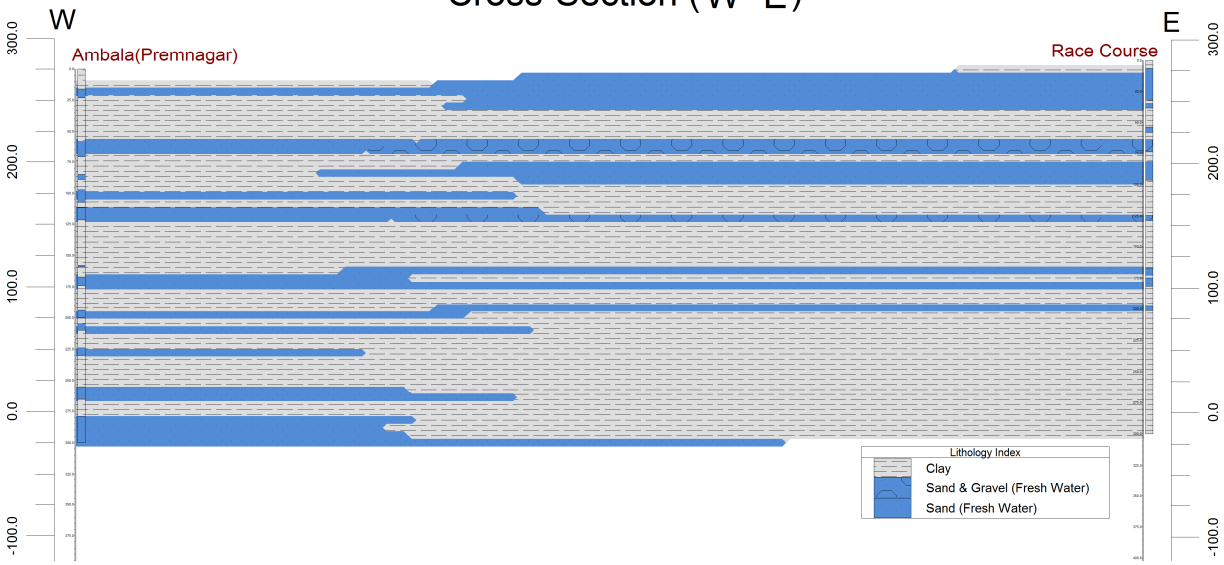
## 3D Lithology model



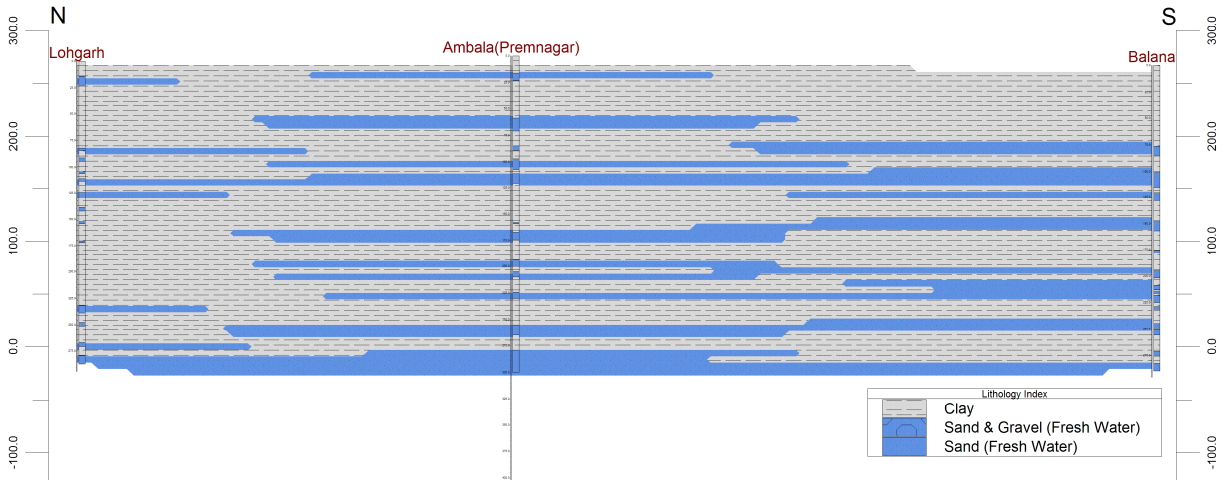

## 3D Lithology Fence



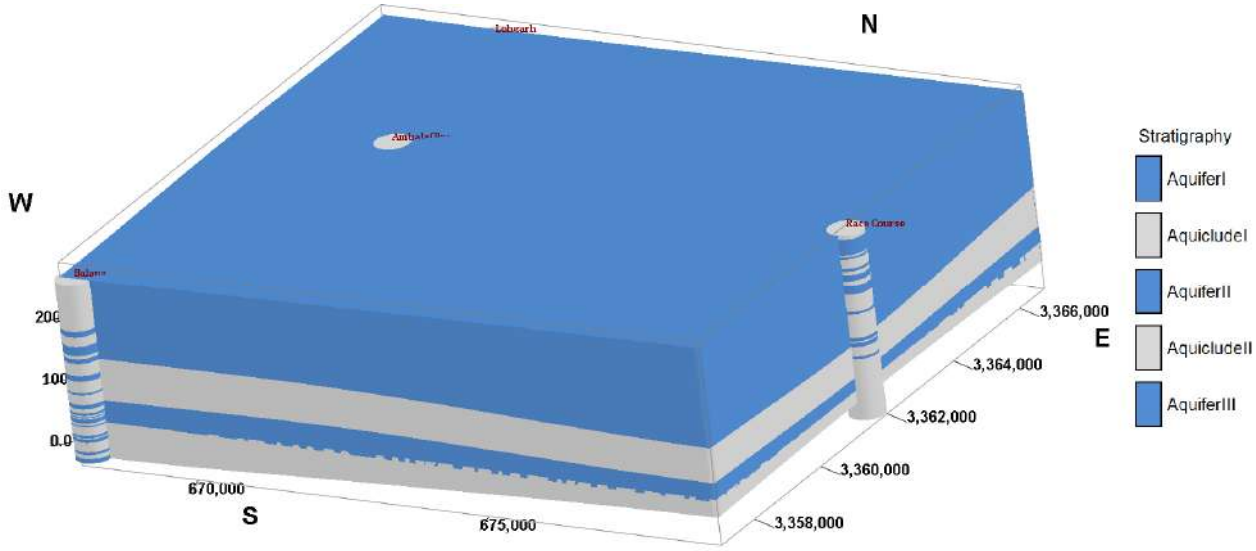
## Cross-Section (W-E)



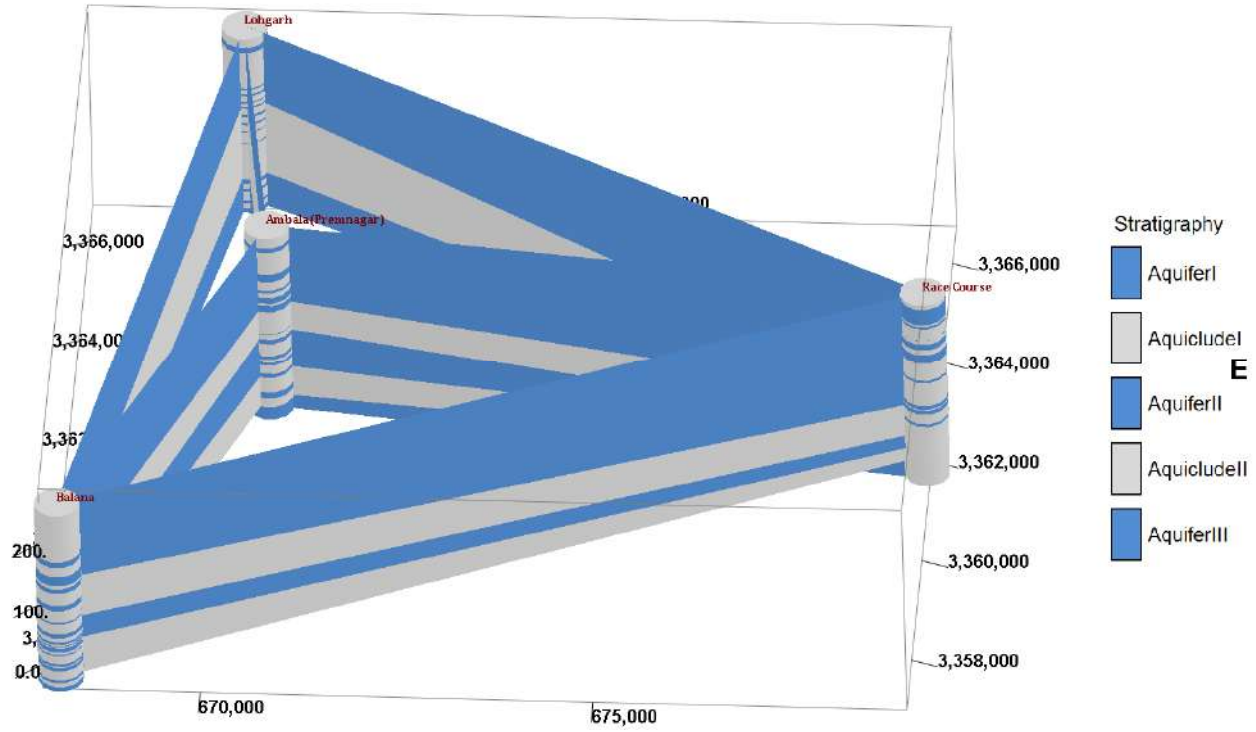

## Cross-Section N-S

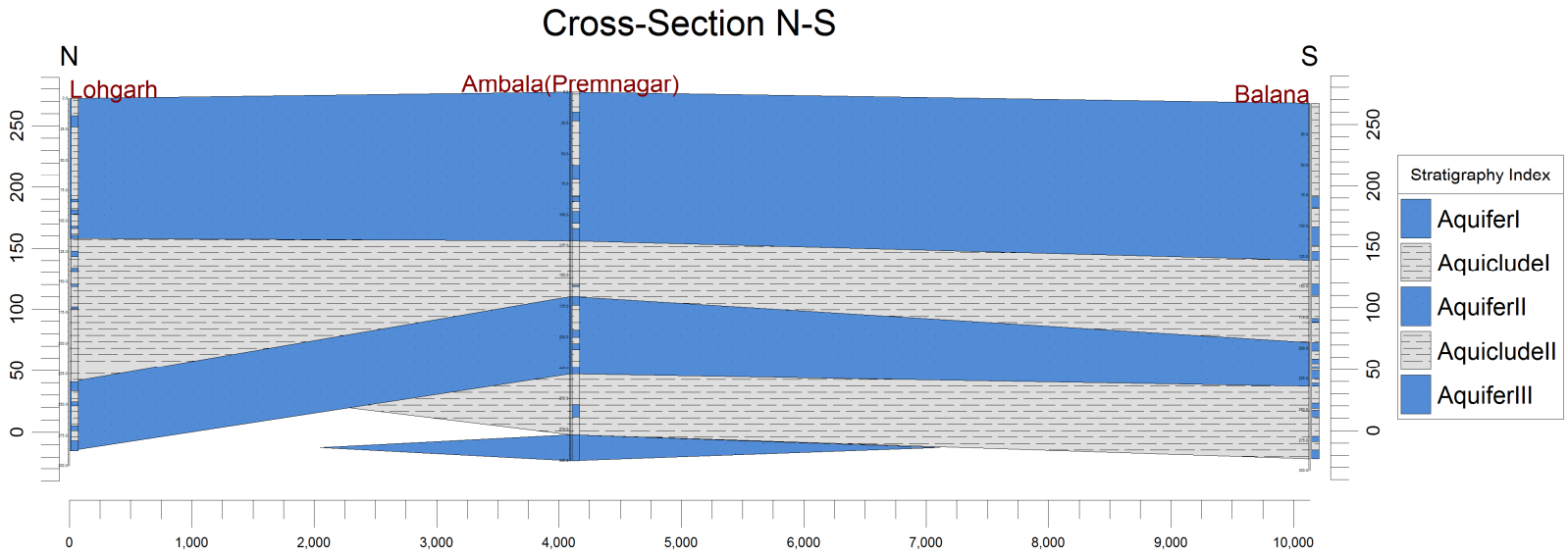


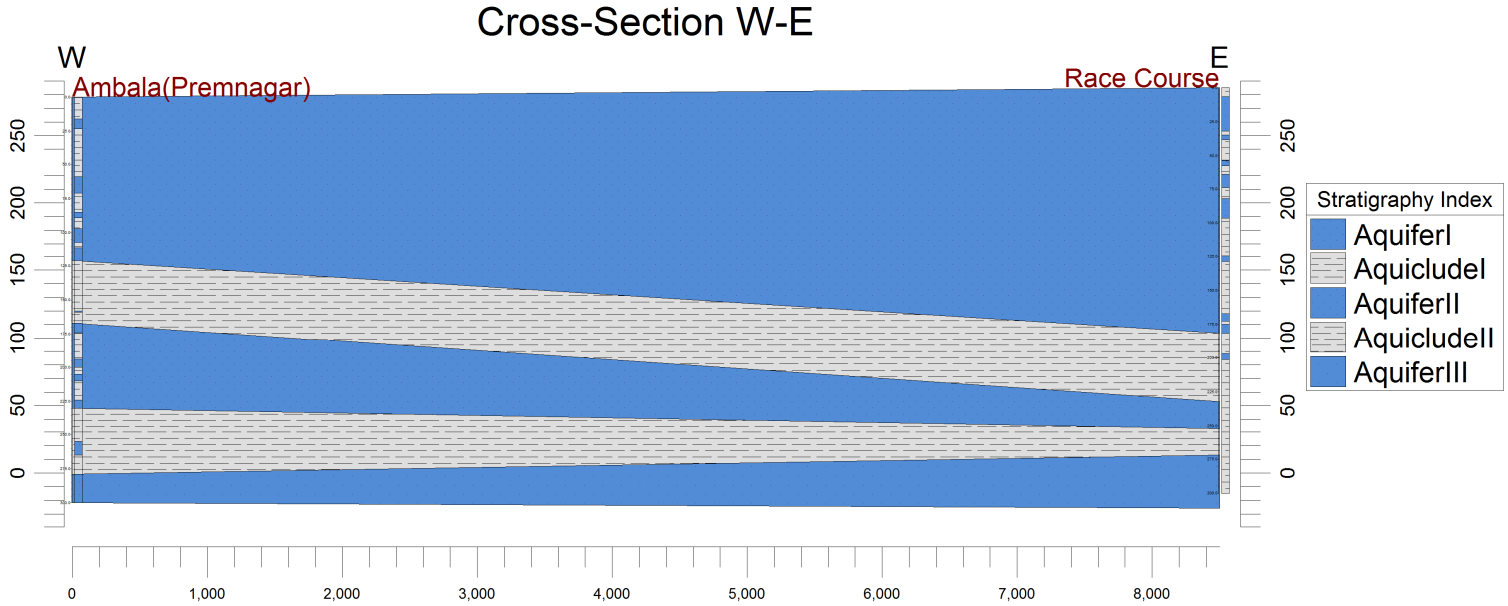
## 3D Aquifer Model




## 3D Aquifer Fence




Cross-Section N-S
N
S
Lohgarh
Ambala(Premnagar)
Balana
0
50
100
150
200
250
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
10,000
Stratigraphy Index
AquiferI
AquicludeI
AquiferII
AquicludeII
AquiferIII


Cross-Section W-E
W
E
Ambala(Premnagar)
Race Course
0
50
100
150
200
250
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
Stratigraphy Index
AquiferI
AquicludeI
AquiferII
AquicludeII
AquiferIII

**Ground Water Resource, extraction, contamination and other issues**

| | | |
|---|---|---|
| Ground Water Resources (in mcm) | Dynamic Aquifer I (2013) | 140.72 |
| | In-storage Aquifer I(2013) | 1200.44 |
| | Dynamic Aquifer II | 81.11 |
| | In-storage Aquifer II | 800.29 |
| | Dynamic Aquifer III | - |
| | In-storage Aquifer III | 886.04 |
| | Total | 3108.6 |
| Ground Water Extraction (in mcm) | Irrigation (2013) | 100.18 |
| | Domestic & Industrial(2013) | 13.05 |
| Future Demand for domestic & Industrial sector (2025) (in mcm) | | 5.22 |
| Chemical Quality of ground water | | Potable for drinking and irrigation (Details in Annexure I) |
| Other issues | | Nil |

**Ground Water Resource Enhancement**

| | |
|---|---|
| Aquifer wise space available for recharge and proposed interventions | Volume of unsaturated zone upto the average depth to water level (4.68m) is 0 mcm. |
| Other interventions proposed | NA |

**Demand Side Interventions**

| | |
|---|---|
| Advanced Irrigation Practices | Lining of underground pipelines (Kutcha channel) will save 6.61mcm volume of water wastage |
| Change in cropping pattern | NA |
| Alternate water sources | Tanks, ponds and canals |
| Regulation and Control | No, Not Notified |
| Other interventions proposed, if any | - |

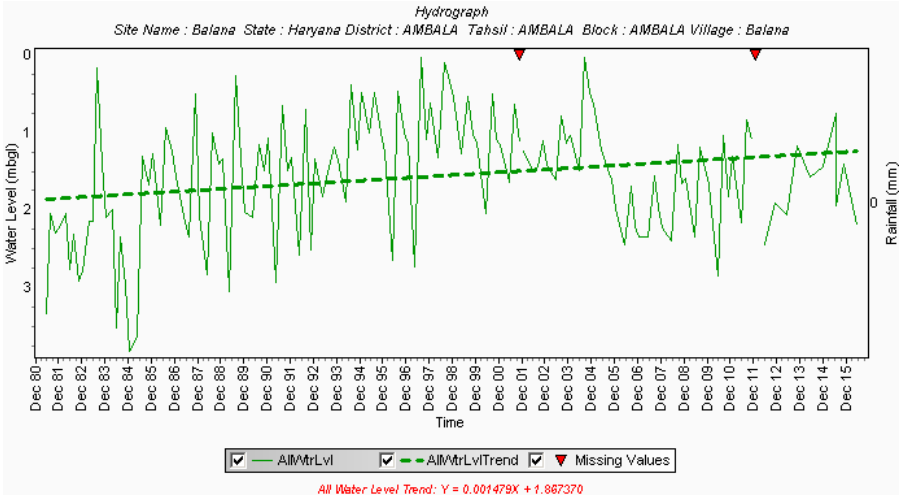
## ii. AMBALA –II BLOCK (147 Sq. km.)

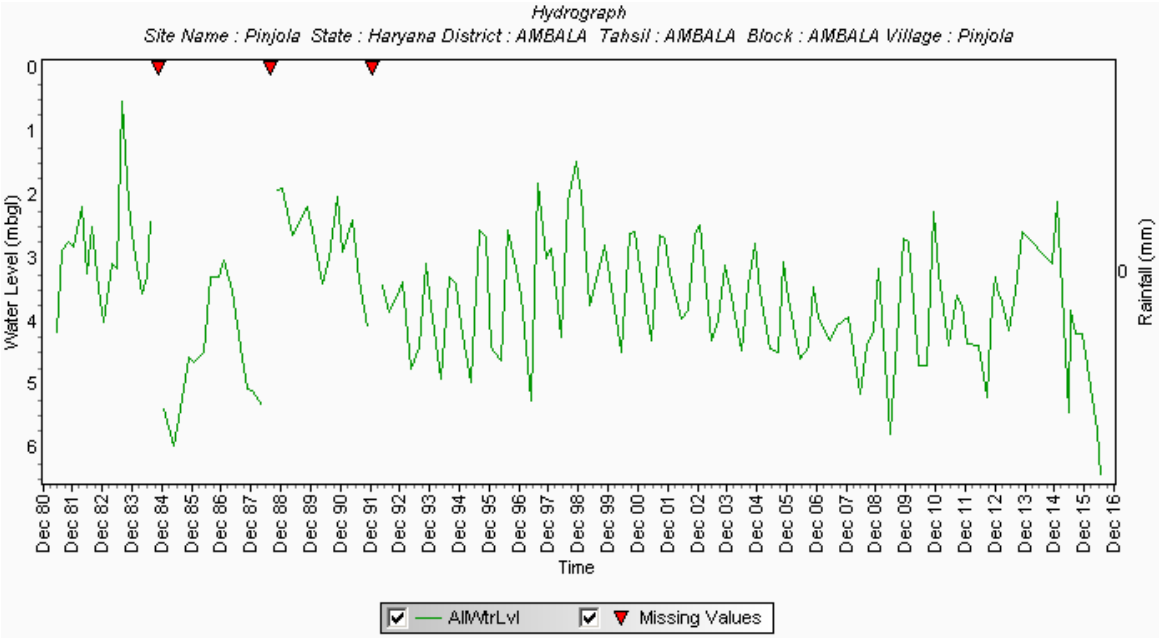
| | |
|---|---|
| **Population (2011)** | Rural-63938<br>Urban-80516<br>Total-144454 |
| **Rainfall** | Monsoon -454mm<br>Non Monsoon-144.40mm |
| **Average Annual Rainfall** | 599.40mm |
| **Agriculture and Irrigation** | Major Crops- Rice, Wheat, Maize, Bajra<br>Other crops-Barley, Pulses, Oilseeds, Sugarcane, potatoes, chillies<br>Net Area Sown-64.18 sqkm<br>Total Irrigated Area-61.86 sqkm |
| **Water Bodies** | 58 nos. |

**Ground Water Resource Availability**: Ground Water Resources available in the different group of aquifers. Aquifer I (131m) is very prominent in terms of thickness and geographic extent. Aquifer II (70m) & Aquifer III (45m) are less in thickness. Block is categorized as Semi-Critical as per 2013 assessment.

**Ground water Extraction**: Information regarding the abstraction from Aquifer II is not available, but there are drinking water supply tapping combined aquifer and separate aquifer could not be assessed separately.

**Water level Behavior(2015):**Pre Monsoon-1.20–8.21mbgl&Post Monsoon-1.10-4.29mbgl






**Aquifer Disposition:** Multiple Aquifer System (3 Aquifer System)

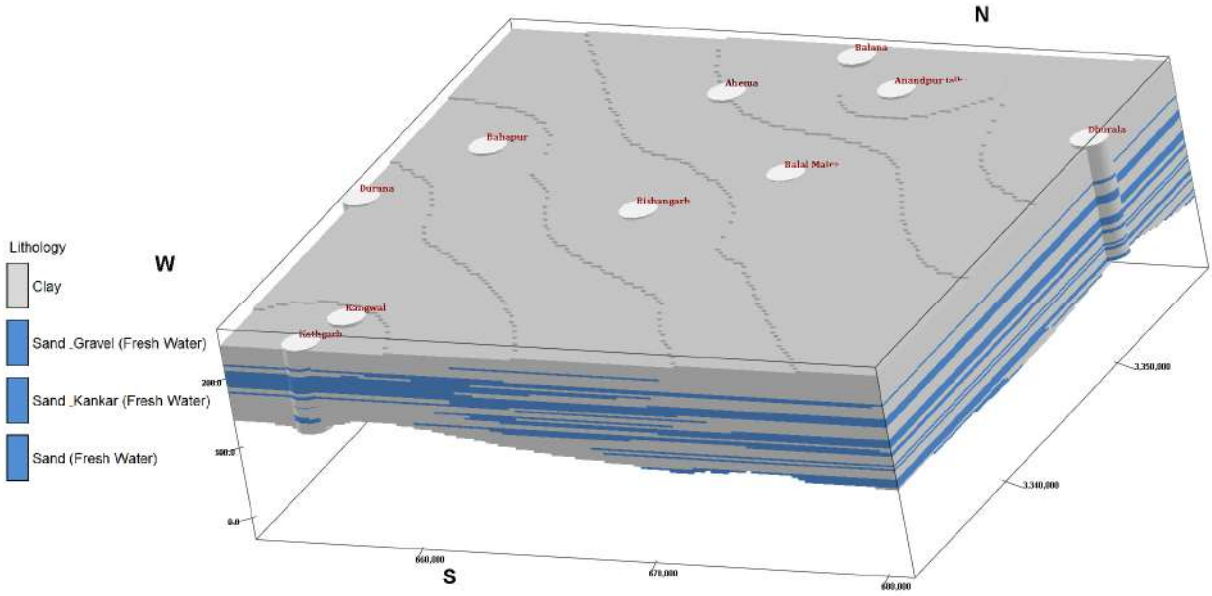
| Aquifer | Geology | Type of Aquifer | Thickness of Granular Zones (m) | Transmissivity ($m^2$/day) | Specific Yield % | Storativity |
|---|---|---|---|---|---|---|
| Aq-I (9-140m) | Quaternary Alluvial deposits | Unconfined | 47 | 577 | 12 | NA |
| Aq-II (186-256m) | | Unconfined to Confined | 34 | - | NA | $1.39x10^{-3}$ |
| Aq-II (255-300m) | | Unconfined to Confined | 31 | - | NA | $1.39x10^{-3}$ |

**Aquifer Disposition**

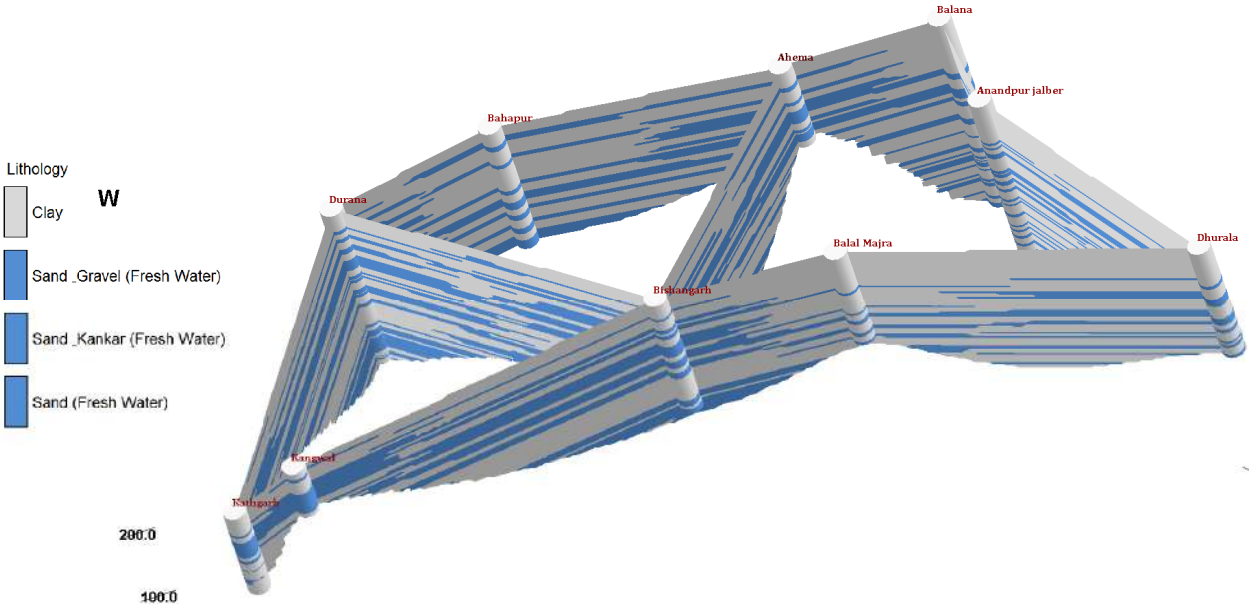
Multiple Aquifer System (3 Aquifer System)

Aquifer comprises of freshwater only and the main aquifer formations are gravel, kankar and sand. The non-aquifer material comprise of clay.

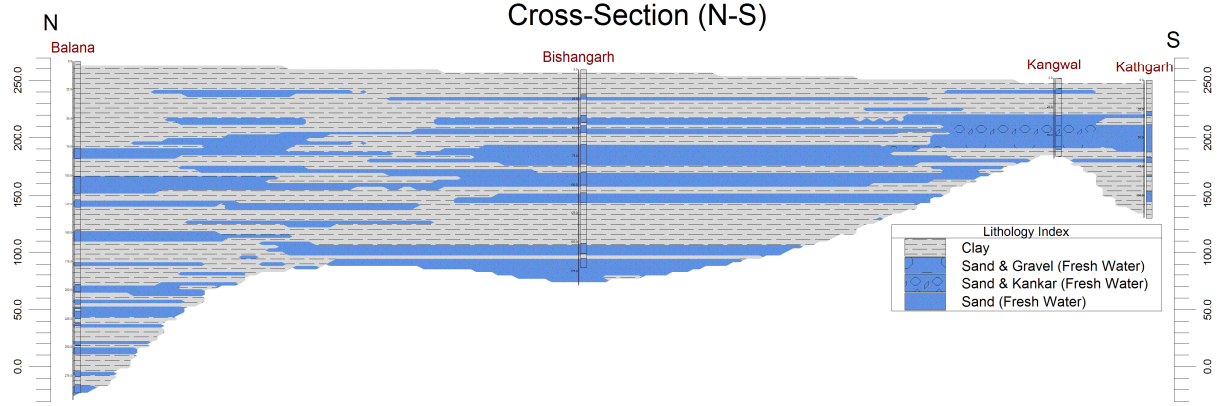
## 3D Lithology model



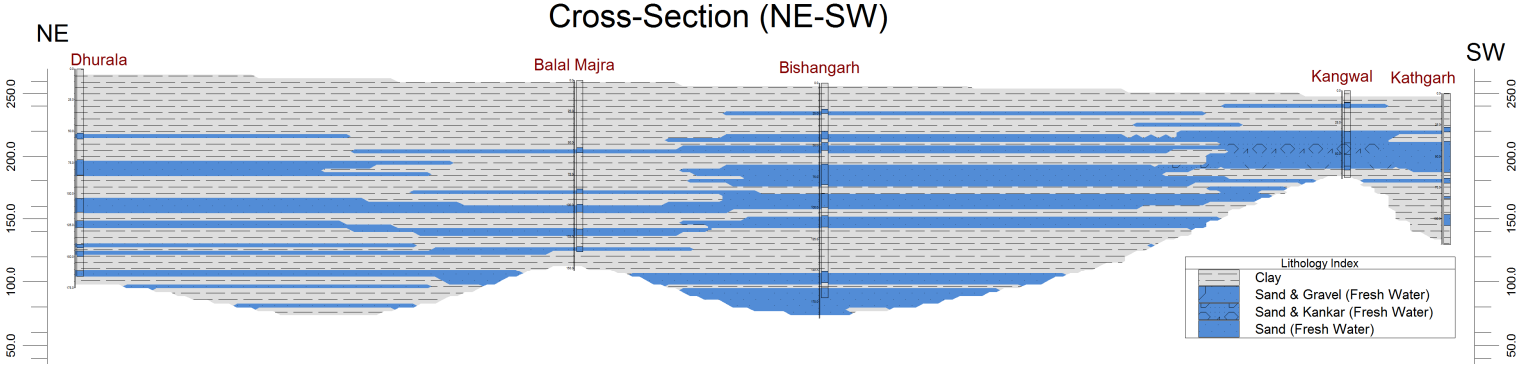

## 3D Lithology Fence



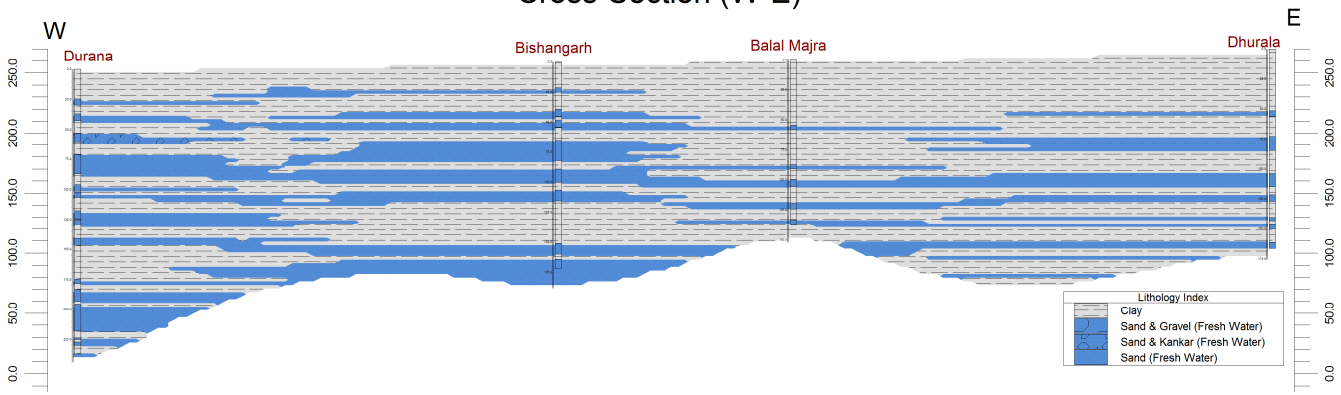
## Cross-Section (N-S)



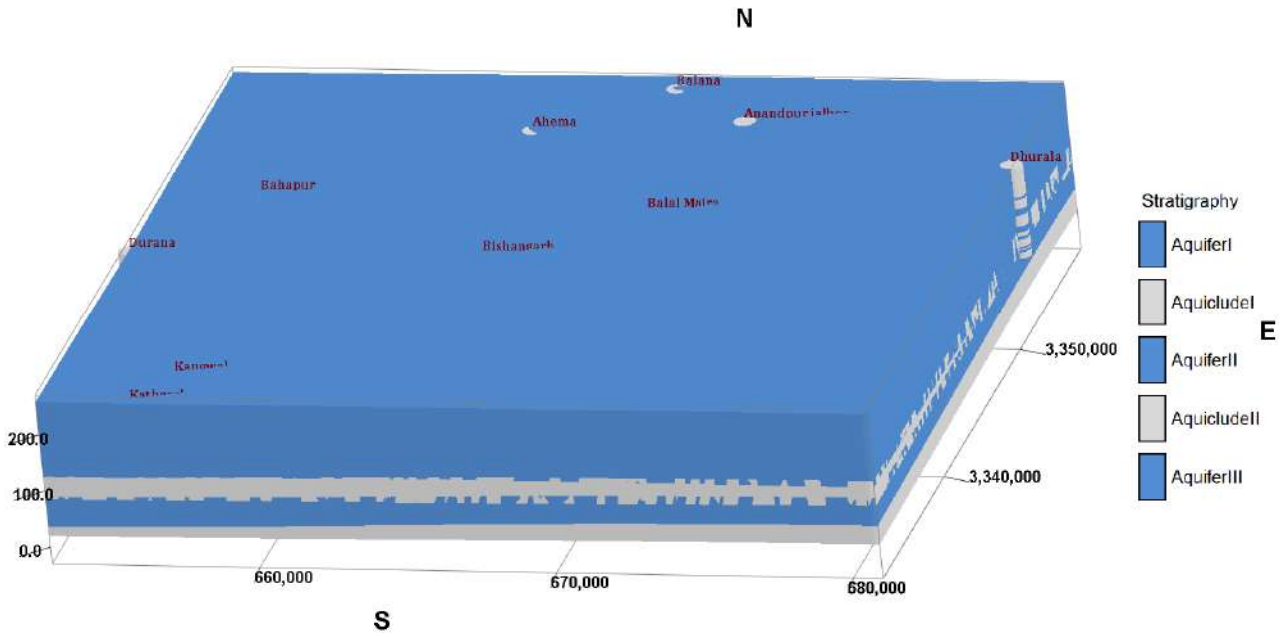

## Cross-Section (NE-SW)



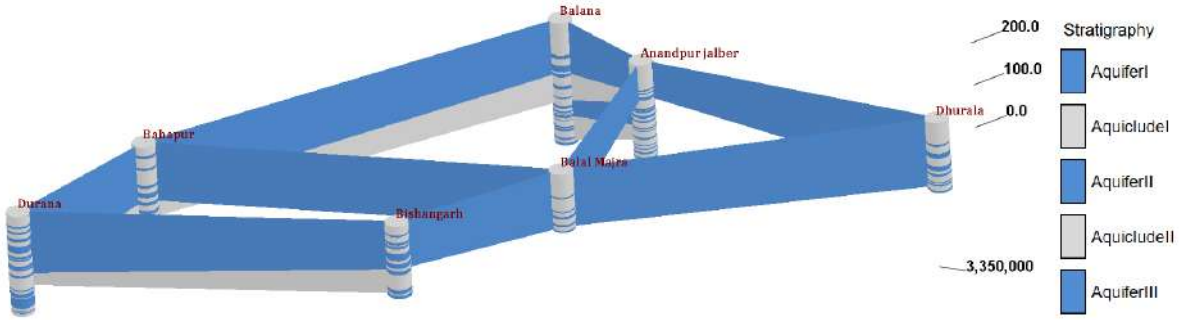

## Cross-Section (W-E)

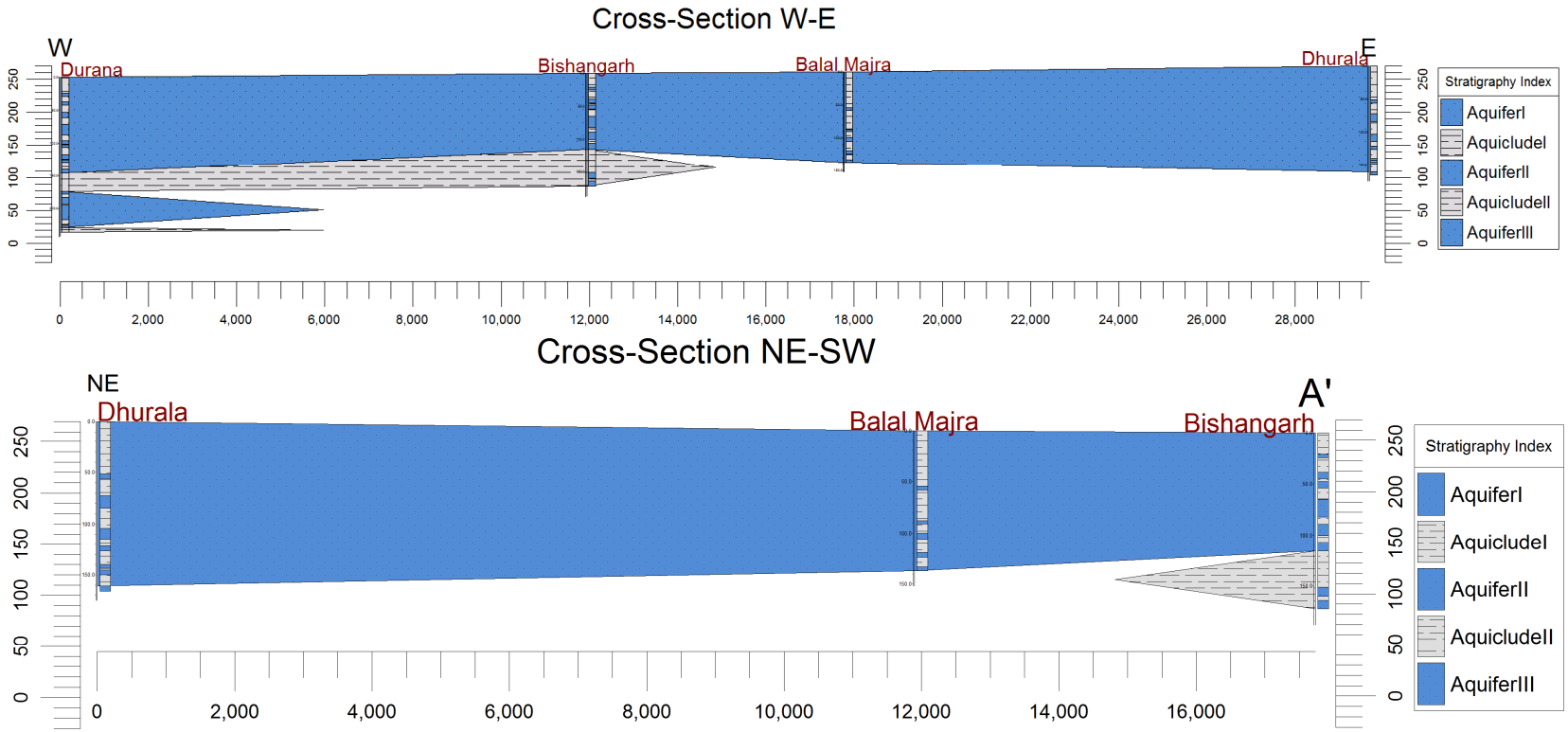


## 3D Aquifer Model




## 3D Aquifer Fence




Cross-Section W-E
W
E
Durana
Bishangarh
Balal Majra
Dhurala
Stratigraphy Index
AquiferI
AquicludeI
AquiferII
AquicludeII
AquiferIII
0
50
100
150
200
250
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
16,000
18,000
20,000
22,000
24,000
26,000
28,000
Cross-Section NE-SW
NE
A'
Dhurala
Balal Majra
Bishangarh
Stratigraphy Index
AquiferI
AquicludeI
AquiferII
AquicludeII
AquiferIII
0
50
100
150
200
250
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
16,000

**Ground Water Resource, Extraction, Contamination and Other Issues**

| | | |
|---|---|---|
| Ground Water Resources (in mcm) | Dynamic Aquifer I (2013) | 74.08 |
| | In-storage Aquifer I (2013) | 497.45 |
| | Dynamic Aquifer II | 30.45 |
| | In-storage Aquifer II | 359.86 |
| | Dynamic Aquifer III | - |
| | In-storage Aquifer III | 328.10 |
| | Total | 1290 |
| Ground Water Extraction (in mcm) | Irrigation (2013) | 55.93 |
| | Domestic & Industrial (2013) | 11.70 |
| Future Demand for domestic & Industrial sector (2025) (in mcm) | | 1.93 |
| Chemical Quality of ground water | | Potable for drinking and irrigation |
| Other issues | | Nil |

**Ground Water Resource Enhancement**

| | |
|---|---|
| Aquifer wise space available for recharge and proposed interventions | Volume of unsaturated zone upto the average depth to water level (4.39m) is0 mcm. |
| Other interventions proposed | NA |

**Demand Side Interventions**

| | |
|---|---|
| Advanced Irrigation Practices | Lining of underground pipelines (Kutcha channel) will save 3.69mcm volume of water wastage |
| Change in cropping pattern | NA |
| Alternate water sources | Tanks, ponds and canals |
| Regulation and Control | No, Not notified |
| Other interventions proposed, if any | - |

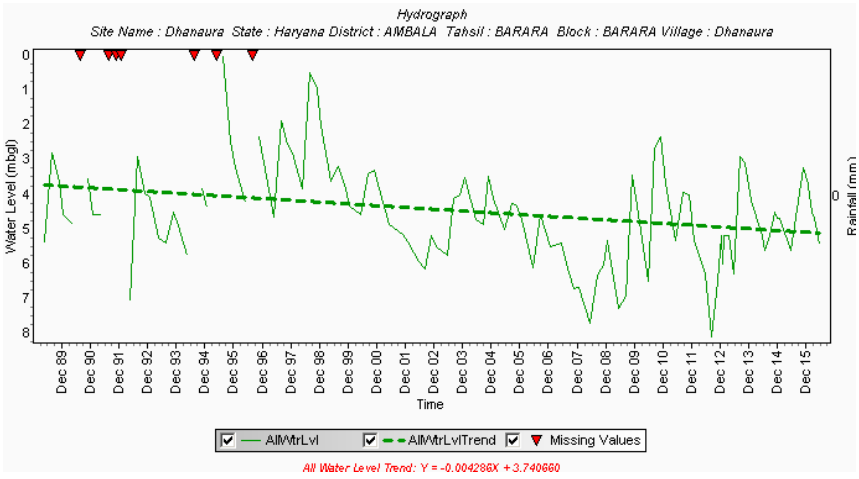
## iii. BARARA BLOCK (265.50 Sq. km.)

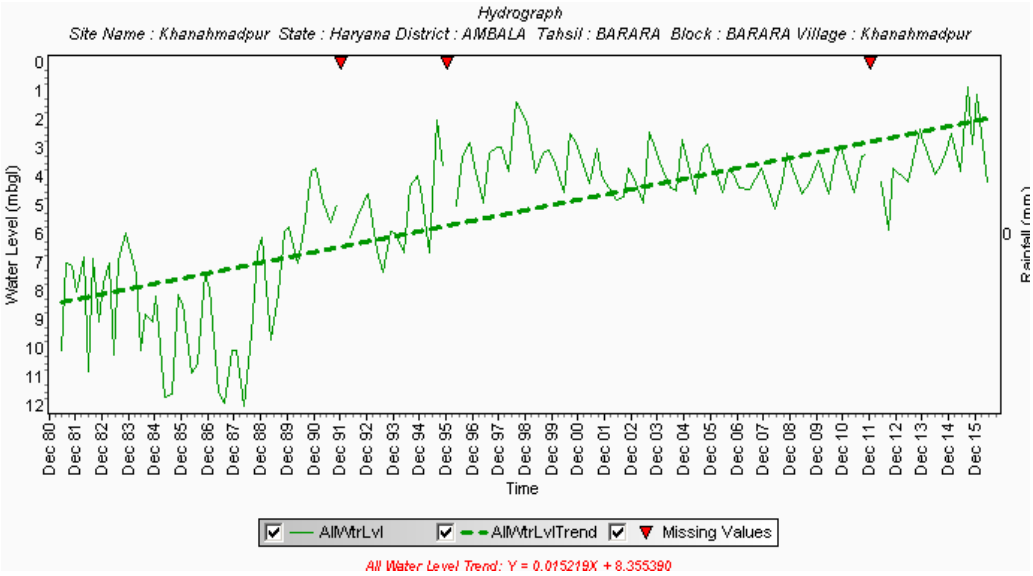
| | |
|---|---|
| **Population (2011)** | Rural-120662<br>Urban-21545<br>Total-142207 |
| **Rainfall** | Monsoon -394 mm<br>Non Monsoon-136.20 mm |
| **Average Annual Rainfall** | 530.20 mm |
| **Agriculture and Irrigation** | Major Crops- Rice, Wheat, Maize, Bajra(Dist)<br>Other crops-Barley, Pulses, Oilseeds, Sugarcane, potatoes, chillies(Dist)<br>Net Area Sown-194.96sqkm<br>Total Irrigated Area-192.98sqkm |
| **Water Bodies** | 62 nos. |

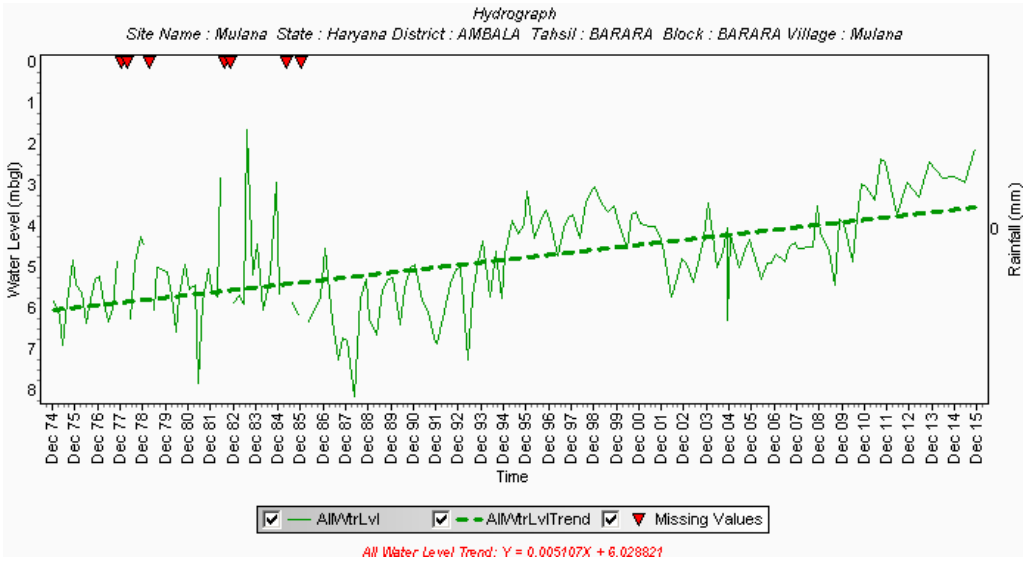
**Ground Water Resource Availability**: Ground Water Resources available in the different group of aquifers. Aquifer I (141m) is very prominent in terms of thickness and geographic extent. Aquifer II (67m) is less in thickness. Block is categorized as Over-Exploited as per 2013 assessment.

**Ground water Extraction**: Information regarding the abstraction from Aquifer II is not available, but there are drinking water supply tapping combined aquifer and separate aquifer could not be assessed separately.

**Water level Behavior (2015):** Pre Monsoon-3.8-34.3mbgl & Post Monsoon-2.8-34.2mbgl





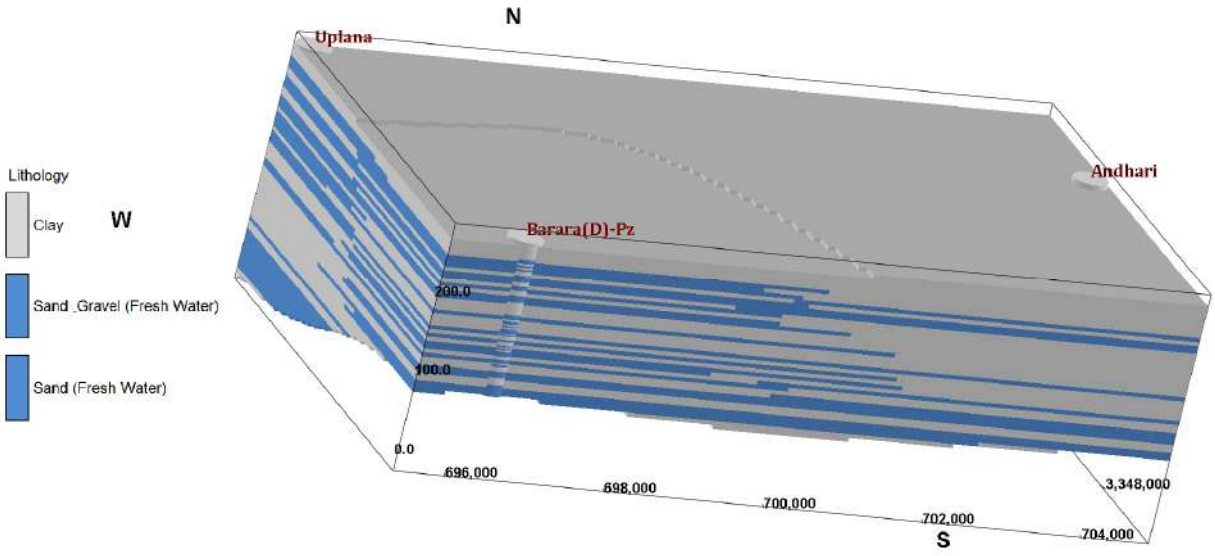

**Aquifer Disposition:** Multiple Aquifer System (2 Aquifer System)

| Aquifer | Geology | Type of Aquifer | Thickness of Granular Zones (m) | Transmissivity ($m^2$/day) | Specific Yield % | Storativity |
|---|---|---|---|---|---|---|
| Aq-I (5-146m) | Quaternary Alluvial deposits | Unconfined | 64 | 154 | 12 | NA |
| Aq-II (220-287m) | | Semi confined to Confined | 51 | - | NA | $1.39x10^{-3}$ |

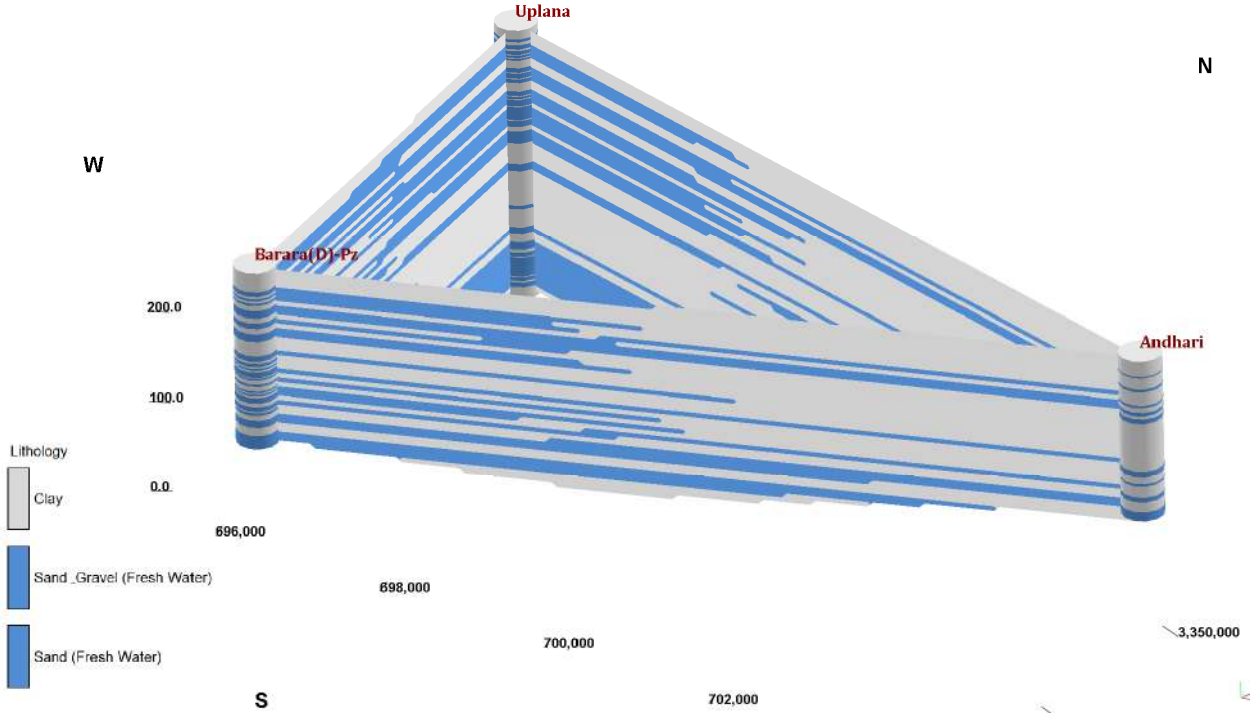
Aquifer comprises of freshwater only and the main aquifer formations are gravel and sand.

The non-aquifer material comprise of clay.

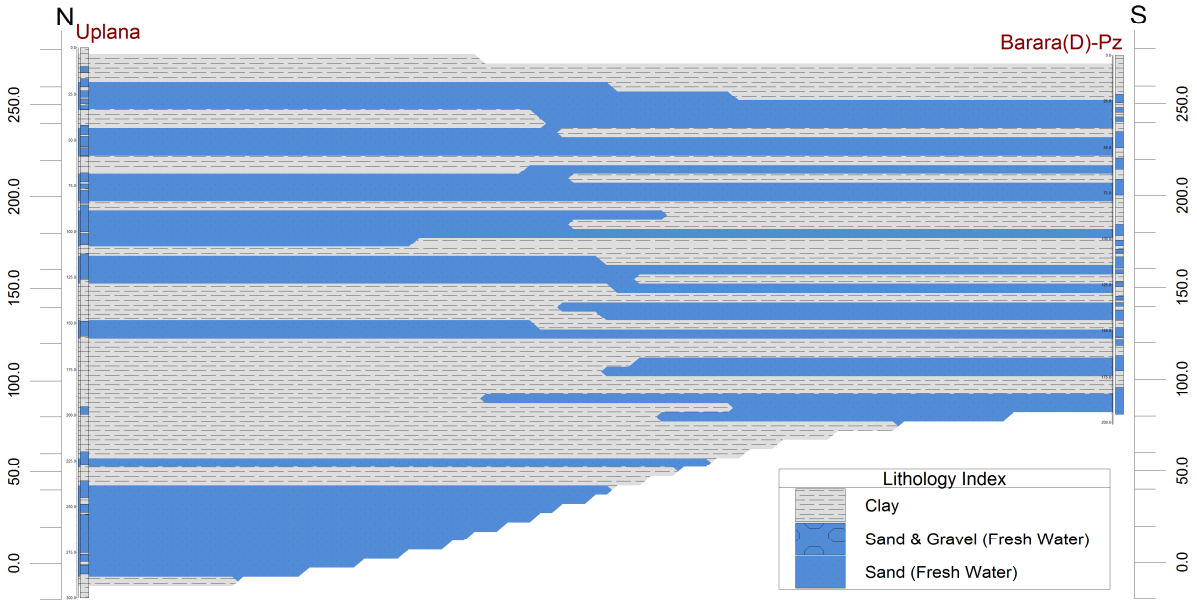
## 3D Lithology model



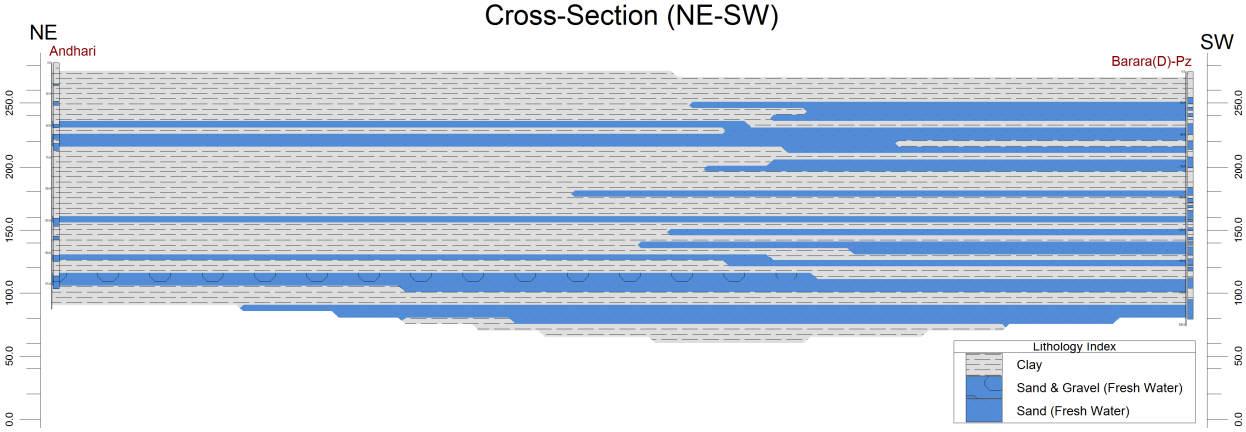

## 3D Lithology Fence



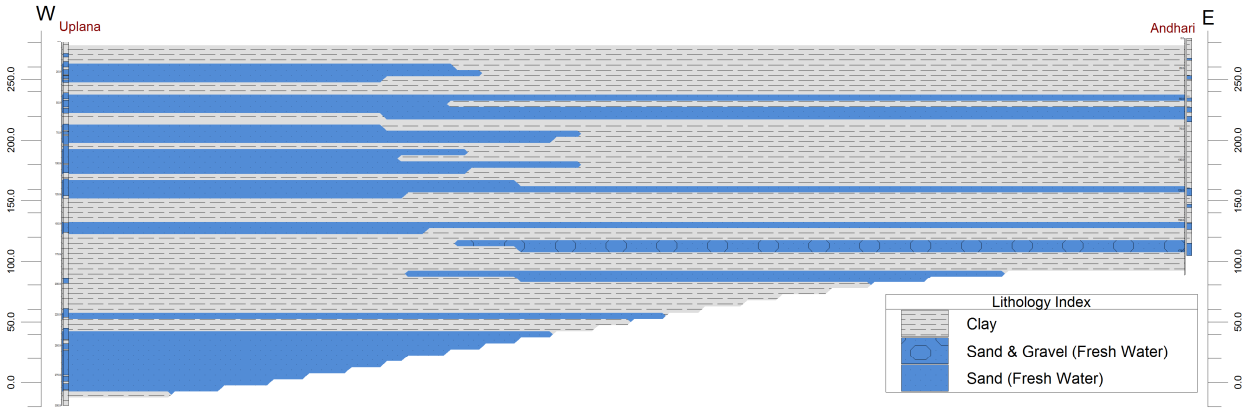
## Cross-Section (N-S)



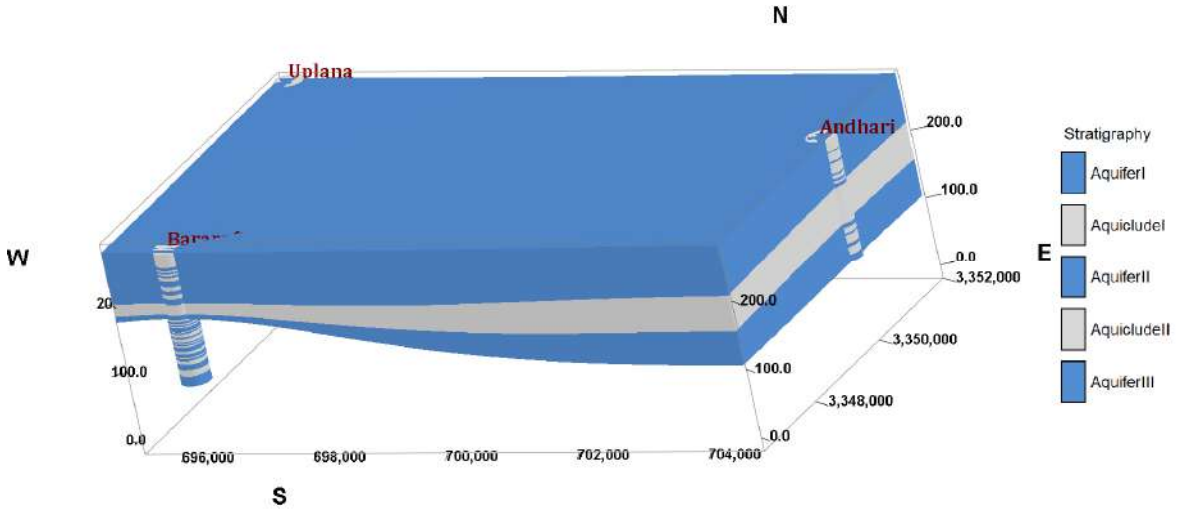

## Cross-Section (NE-SW)



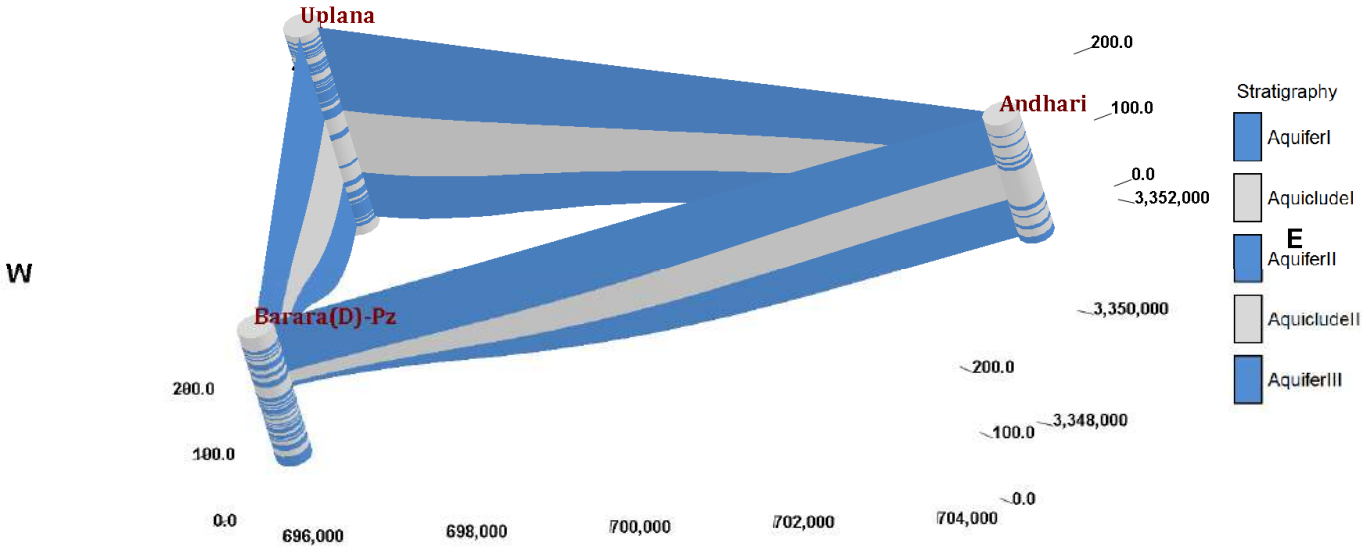

## Cross-Section (W-E)

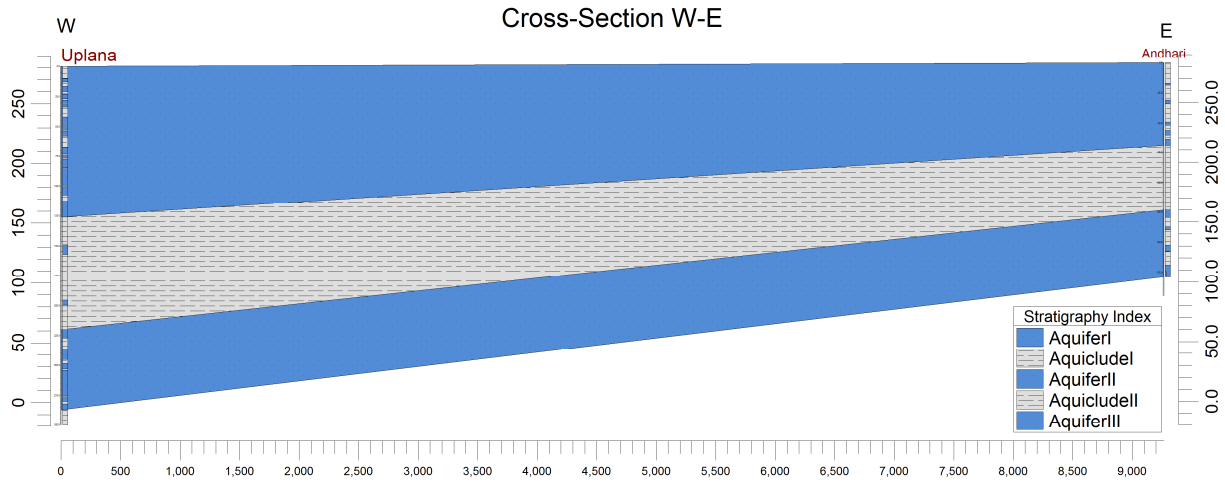


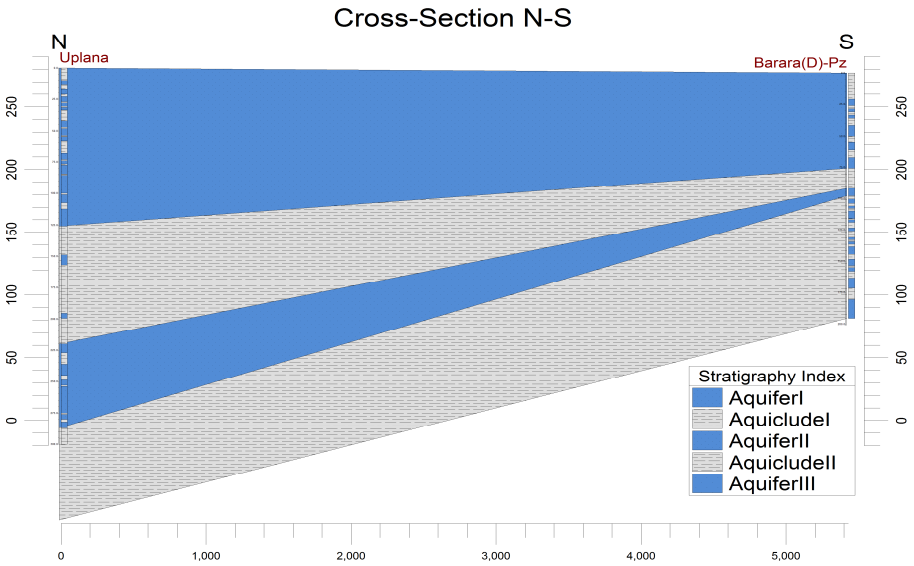
## 3D Aquifer Model

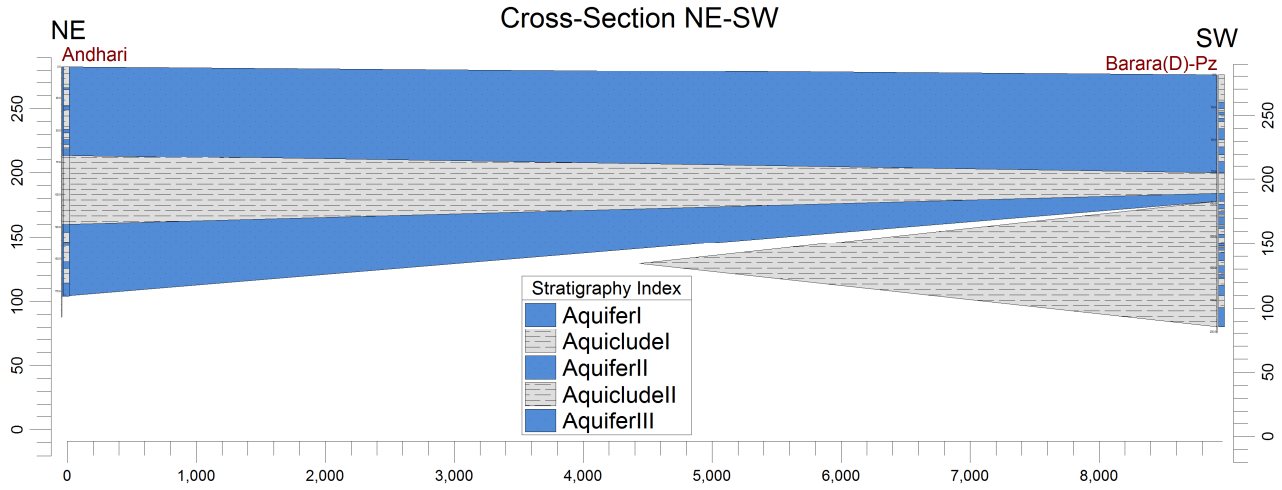



## 3D Aquifer Fence




Cross-Section W-E
W
E
Uplana
Andhari
Stratigraphy Index
AquiferI
AquicludeI
AquiferII
AquicludeII
AquiferIII


Cross-Section N-S
N
S
Uplana
Barara(D)-Pz
Stratigraphy Index
AquiferI
AquicludeI
AquiferII
AquicludeII
AquiferIII


Cross-Section NE-SW
NE
SW
Andhari
Barara(D)-Pz
Stratigraphy Index
AquiferI
AquicludeI
AquiferII
AquicludeII
AquiferIII

**Ground Water Resource, Extraction, Contamination and Other Issues**

| | | |
|---|---|---|
| Ground Water Resources (in mcm) | Dynamic Aquifer I (2013) | 77.80 |
| | In-storage Aquifer I (2013) | 1181.95 |
| | Dynamic Aquifer II | 65.25 |
| | In-storage Aquifer II | 941.87 |
| | Total | 2266.87 |
| Ground Water Extraction (in mcm) | Irrigation (2013) | 86.37 |
| | Domestic & Industrial (2013) | 13.20 |
| Future Demand for domestic & Industrial sector (2025) (in mcm) | | 13.20 |
| Chemical Quality of ground water | | Potable for drinking and irrigation |
| Other issues | | Deeper water level (>5m) & declining water level trend (80.5-99.9cm/yr) |

**Ground Water Resource Enhancement**

| | |
|---|---|
| Aquifer wise space available for recharge and proposed interventions | Volume of unsaturated zone upto the average depth to water level (6.3m) is 0 mcm. |
| Other interventions proposed | Artificial Recharge, Roof top Rainwater Harvesting will save 0.18mcm volume of water |

**Demand Side Interventions**

| | |
|---|---|
| Advanced Irrigation Practices | Lining of underground pipelines (Kutcha channel) will save 5.7mcm volume of water wastage |
| Change in cropping pattern | Proposed change in cropping pattern from Paddy to maize/soyabean in 8% area of the block. Anticipated volume of water to be saved by maize is 15.89mcm. |
| Alternate water sources | Tanks, ponds and canals |
| Regulation and Control | No, Not Notified |
| Other interventions proposed, if any | - |

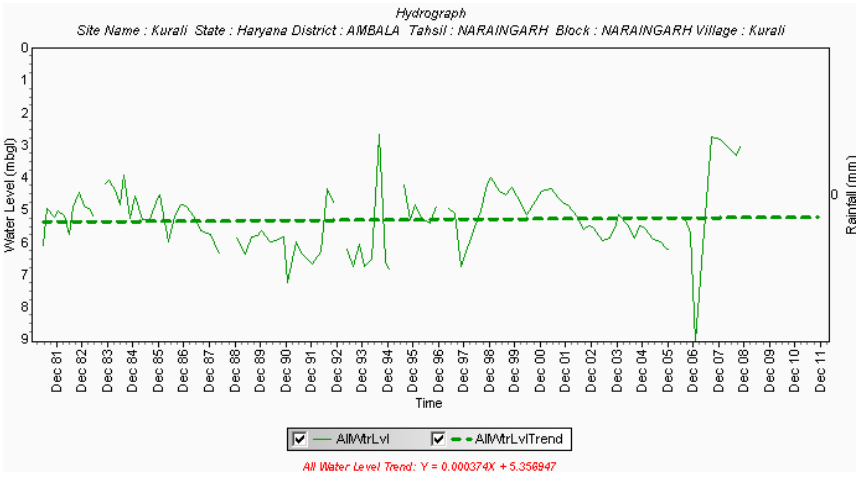
## iv. NARAINGARH BLOCK (270.71 Sq. km.)

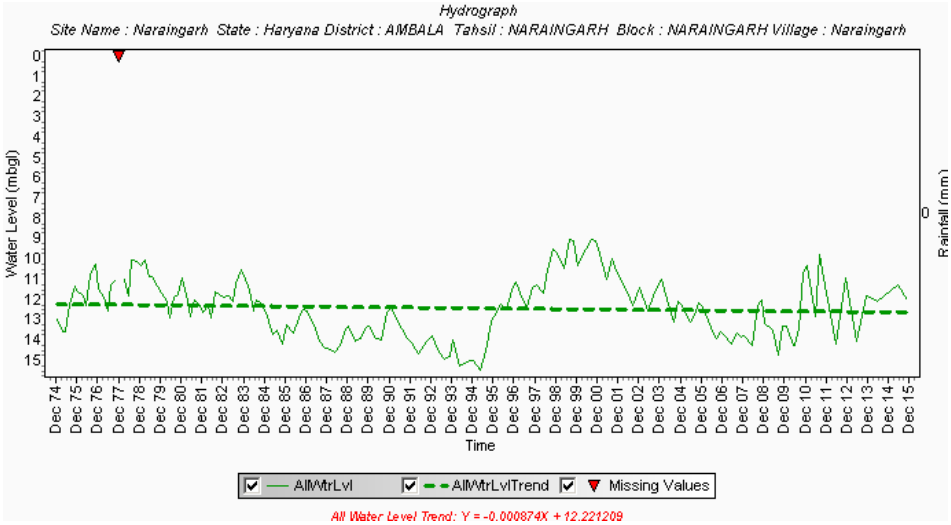
| | |
|---|---|
| **Population (2011)** | Rural-107609 |
| | Urban-0 |
| | Total-107609 |
| **Rainfall** | Monsoon -1202.40 mm |
| | Non Monsoon-199.80 mm |
| **Average Annual Rainfall** | 1422.20 mm |
| **Agriculture and Irrigation** | Major Crops- Rice, Wheat, Maize, Bajra |
| | Other crops-Barley, Pulses, Oilseeds, Sugarcane, potatoes, chillies |
| | Net Area Sown-208.28 sqkm |
| | Total Irrigated Area-196.74 sqkm |
| **Water Bodies** | 56 nos. |

**Ground Water Resource Availability**: Ground Water Resources available in the different group of aquifers. Aquifer I (153m) is very prominent in terms of thickness and geographic extent. Aquifer II (28m) & Aquifer III (28m) are less in thickness. Block is categorized as Over-Exploited as per 2013 assessment.

**Ground water Extraction**: Information regarding the abstraction from Aquifer II is not available, but there are drinking water supply tapping combined aquifer and separate aquifer could not be assessed separately.

**Water level Behavior(2015):**Pre Monsoon-7.6-20.2mbgl & Post Monsoon-6.8-21.7mbgl



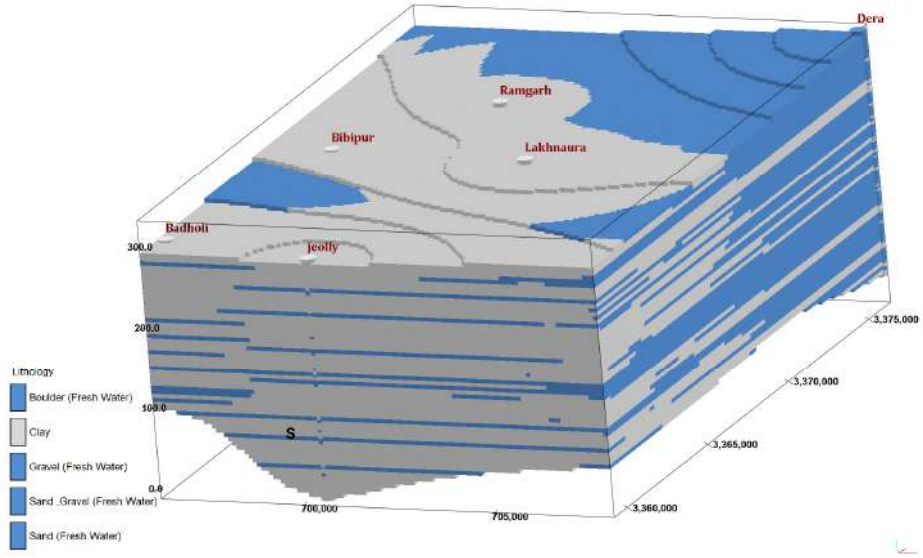



**Aquifer Disposition:** Multiple Aquifer System (3 Aquifer System)

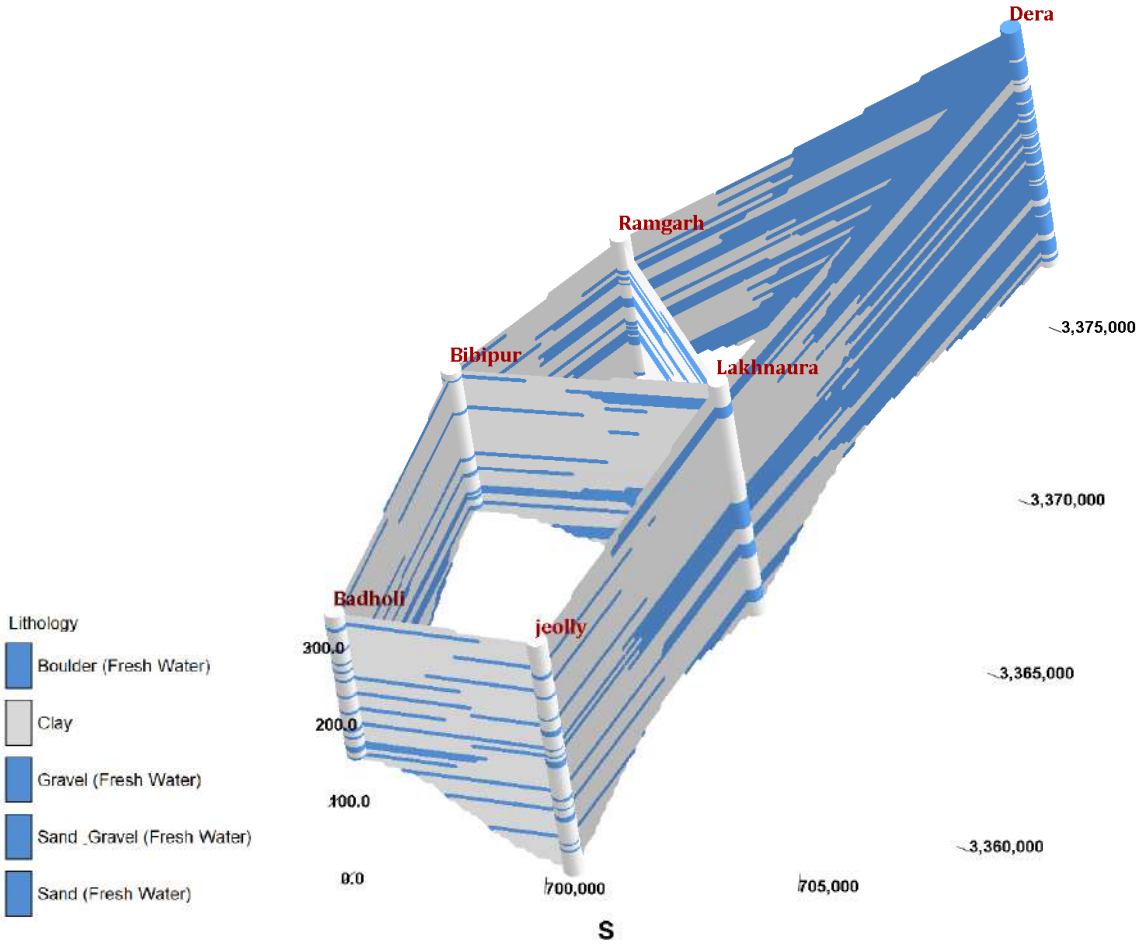
| Aquifer | Geology | Type of Aquifer | Thickness of Granular Zones (m) | Transmissivity ($m^2$/day) | Specific Yield % | Storativity |
|---|---|---|---|---|---|---|
| Aq-I (13-166m) | Quaternary Alluvial deposits | Unconfined | 70 | 1710 | 12 | NA |
| Aq-II (211-239m) | | Semi confined to Confined | 22 | - | NA | $1.39x10^{-3}$ |
| Aq-III (262-290m) | | Semi confined to Confined | 28 | - | NA | $1.39x10^{-3}$ |

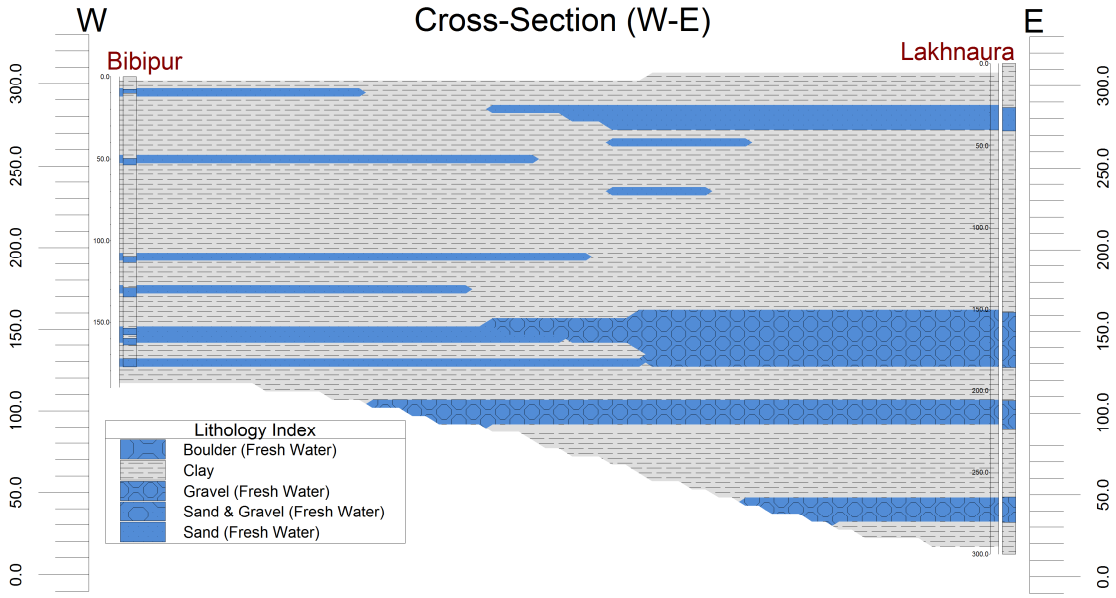
Aquifer comprises of freshwater only and the main aquifer formations are boulder, gravel and sand. The non-aquifer material comprise of clay.

**3D Lithology model**

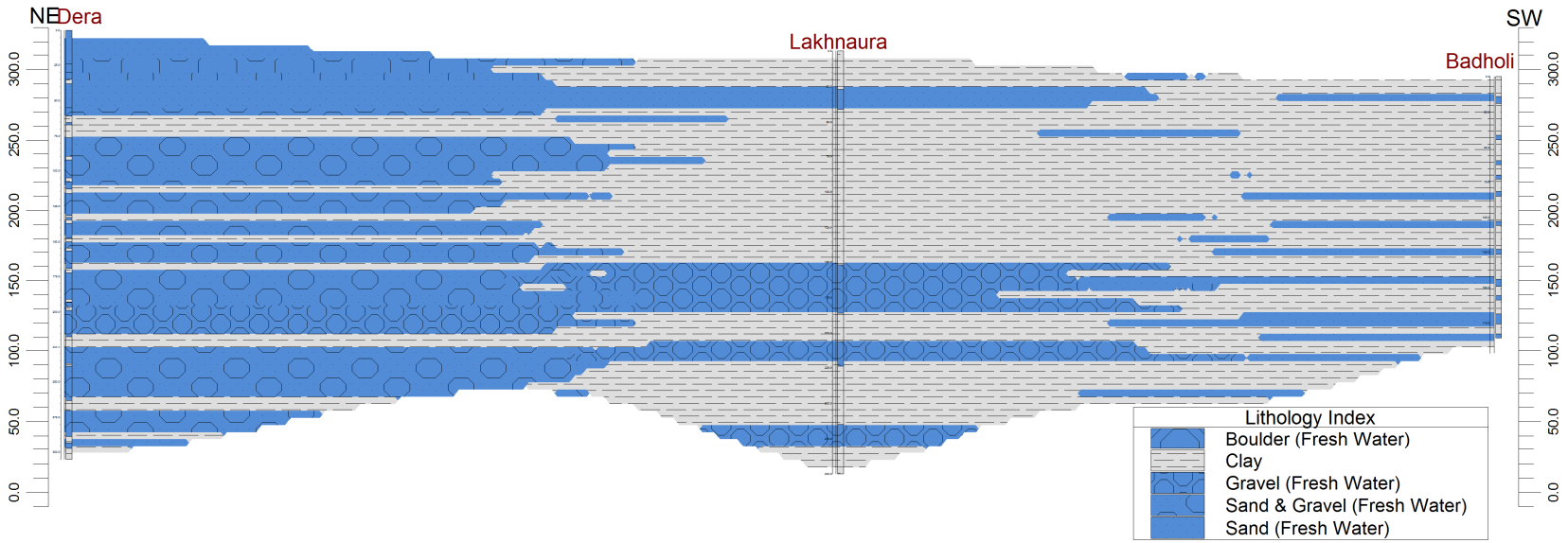


## 3D Lithology Fence

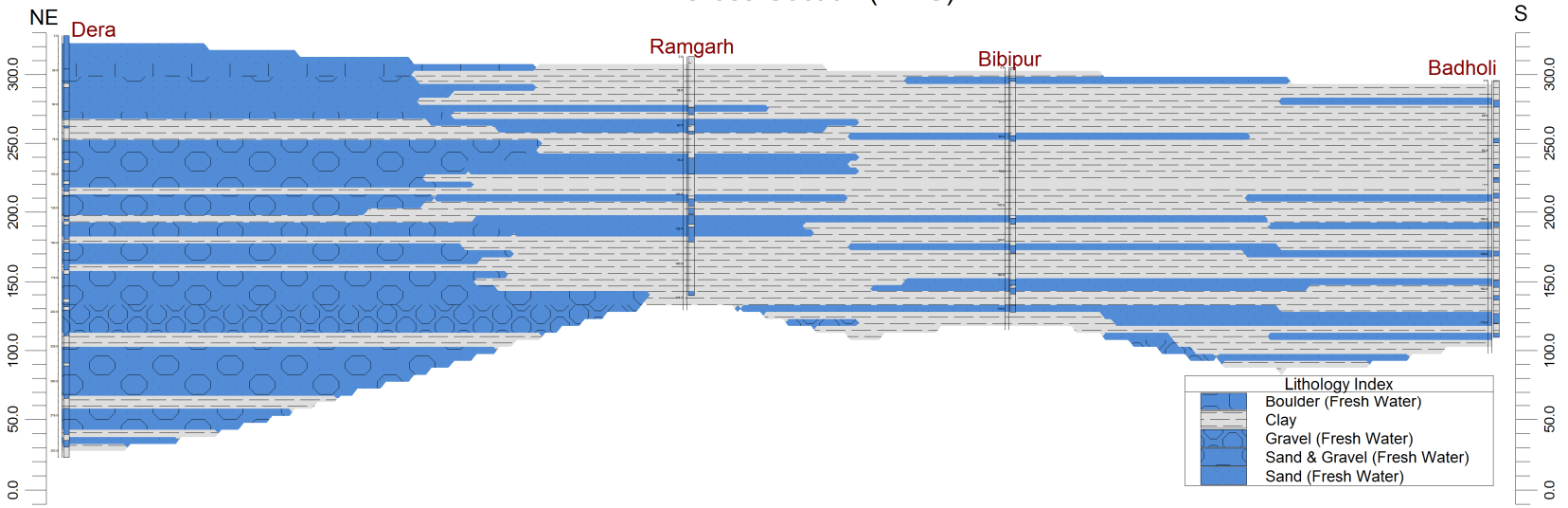


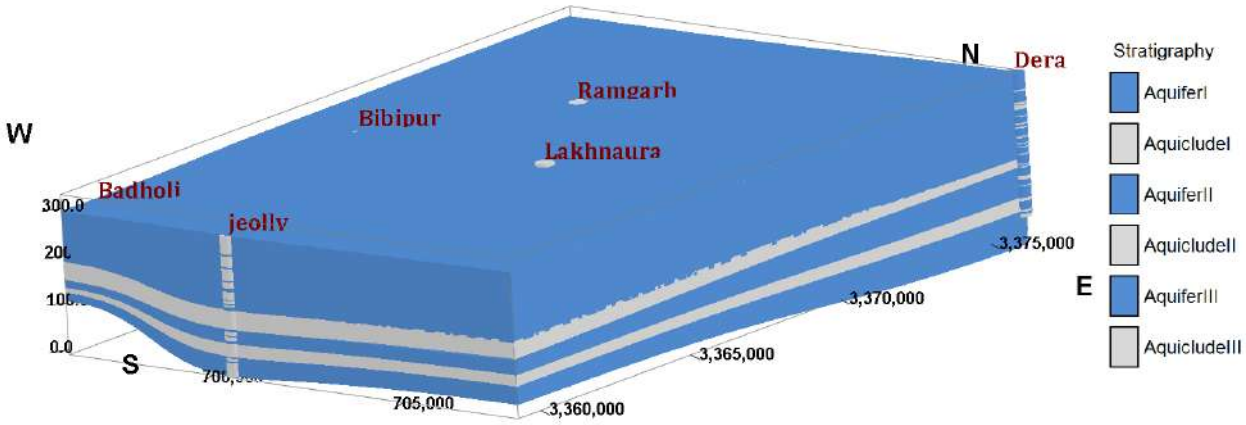
## Cross-Section (NE-SW)



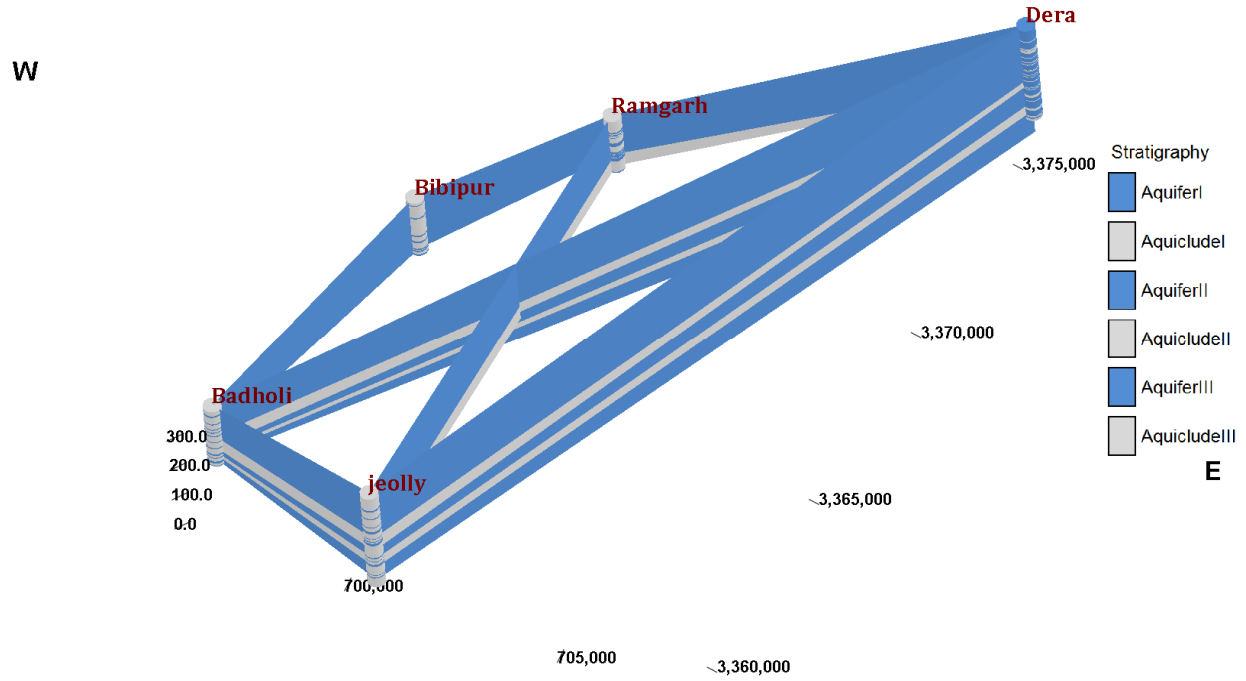

## Cross-Section (NE-S)

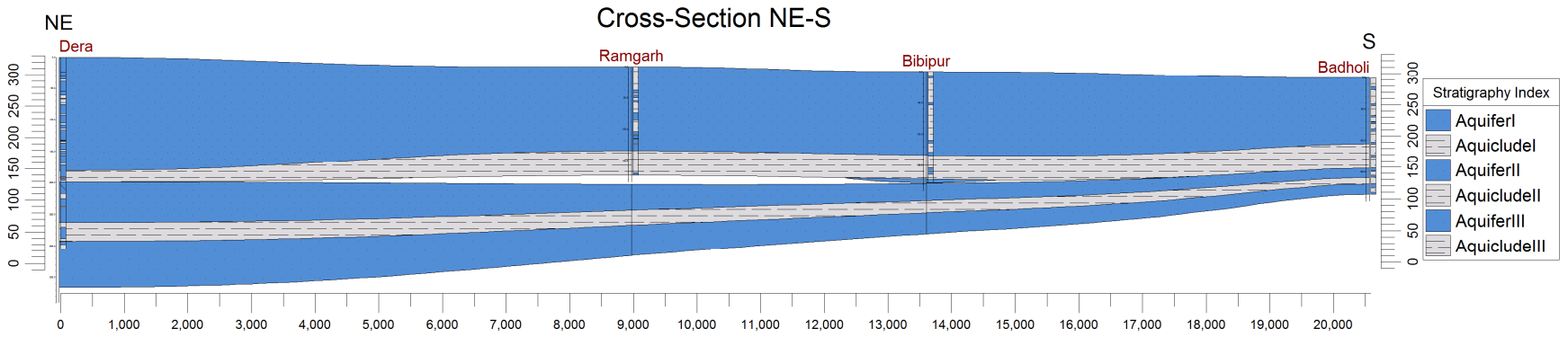


## 3DAquifer Model




## 3D Aquifer Fence




Cross-Section NE-S
NE
Dera
Ramgarh
Bibipur
Badholi
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15,000
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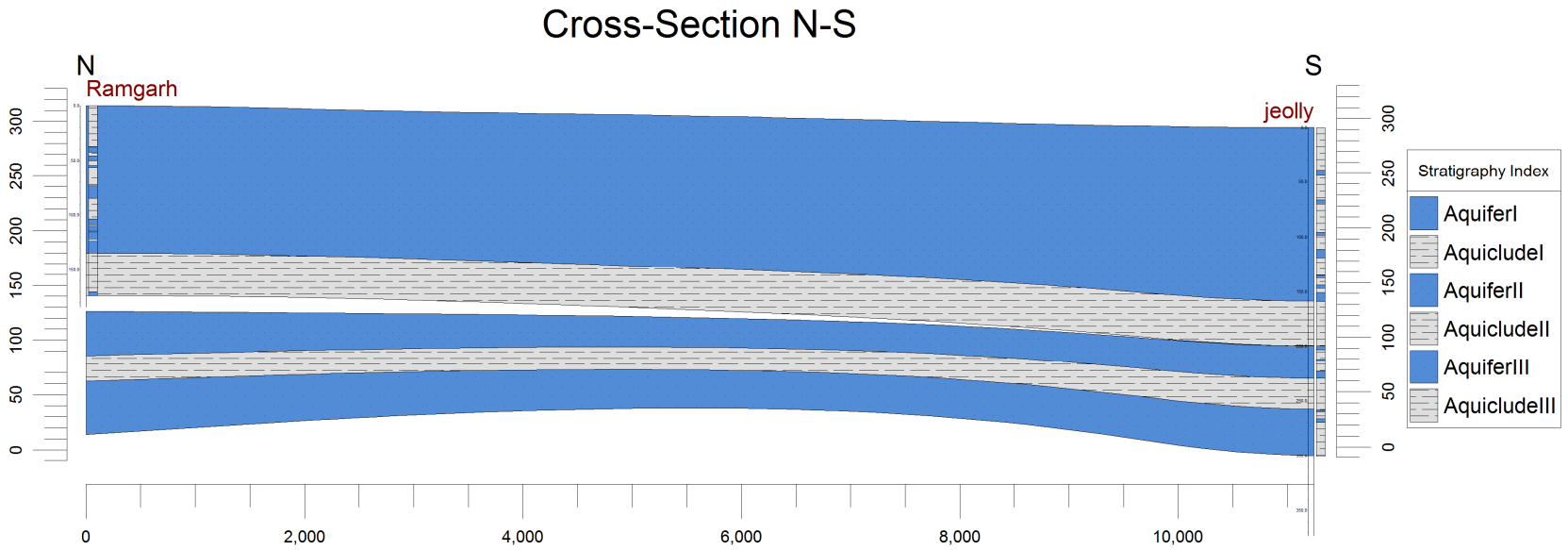
Stratigraphy Index
AquiferI
AquicludeI
AquiferII
AquicludeII
AquiferIII
AquicludeIII


Cross-Section N-S
N
Ramgarh
S
jeolly
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150
200
250
300
0
2,000
4,000
6,000
8,000
10,000
Stratigraphy Index
AquiferI
AquicludeI
AquiferII
AquicludeII
AquiferIII
AquicludeIII

**Ground Water Resource, Extraction, Contamination and Other Issues**

| | | |
|---|---|---|
| Ground Water Resources (in mcm) | Dynamic Aquifer I (2013) | 103.92 |
| | In-storage Aquifer I (2013) | 1349.26 |
| | Dynamic Aquifer II | 64.75 |
| | In-storage Aquifer II | 424.05 |
| | Dynamic Aquifer III | - |
| | In-storage Aquifer III | 212.03 |
| | Total | 2154.01 |
| Ground Water Extraction (in mcm) | Irrigation (2013) | 109.29 |
| | Domestic & Industrial (2013) | 16.20 |
| Future Demand for domestic & Industrial sector (2025) (in mcm) | | 16.20 |
| Chemical Quality of ground water | | Potable for drinking and irrigation |
| Other issues | | Deeper water level (>5m) & declining water level trend (39.1-63.4cm/yr) |

**Ground Water Resource Enhancement**

| | |
|---|---|
| Aquifer wise space available for recharge and proposed interventions | Volume of unsaturated zone upto the average depth to water level (14.19m) is 224.88 mcm. |
| Other interventions proposed | Artificial Recharge, Roof top Rainwater Harvesting will save 1.49mcm volume of water |

**Demand Side Interventions**

| | |
|---|---|
| Advanced Irrigation Practices | Lining of underground pipelines (Kutcha channel) will save 7.21mcm volume of water wastage |
| Change in cropping pattern | Proposed change in cropping pattern from Paddy to maize/soyabean in 10% area of the block.<br>Anticipated volume of water to be saved by maize is 12.84mcm. |
| Alternate water sources | Tanks, ponds and canals |
| Regulation and Control | No, Not Notified |
| Other interventions proposed, if any | - |

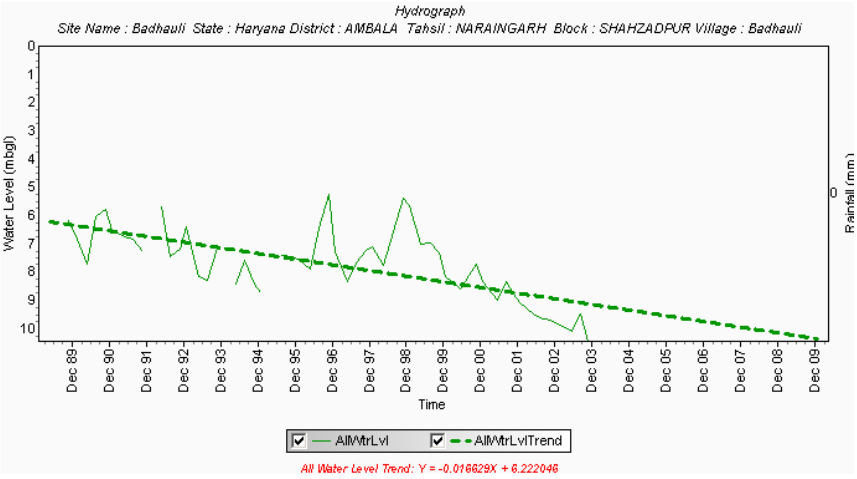
## v. SHAZADPUR BLOCK (285 Sq. km.)

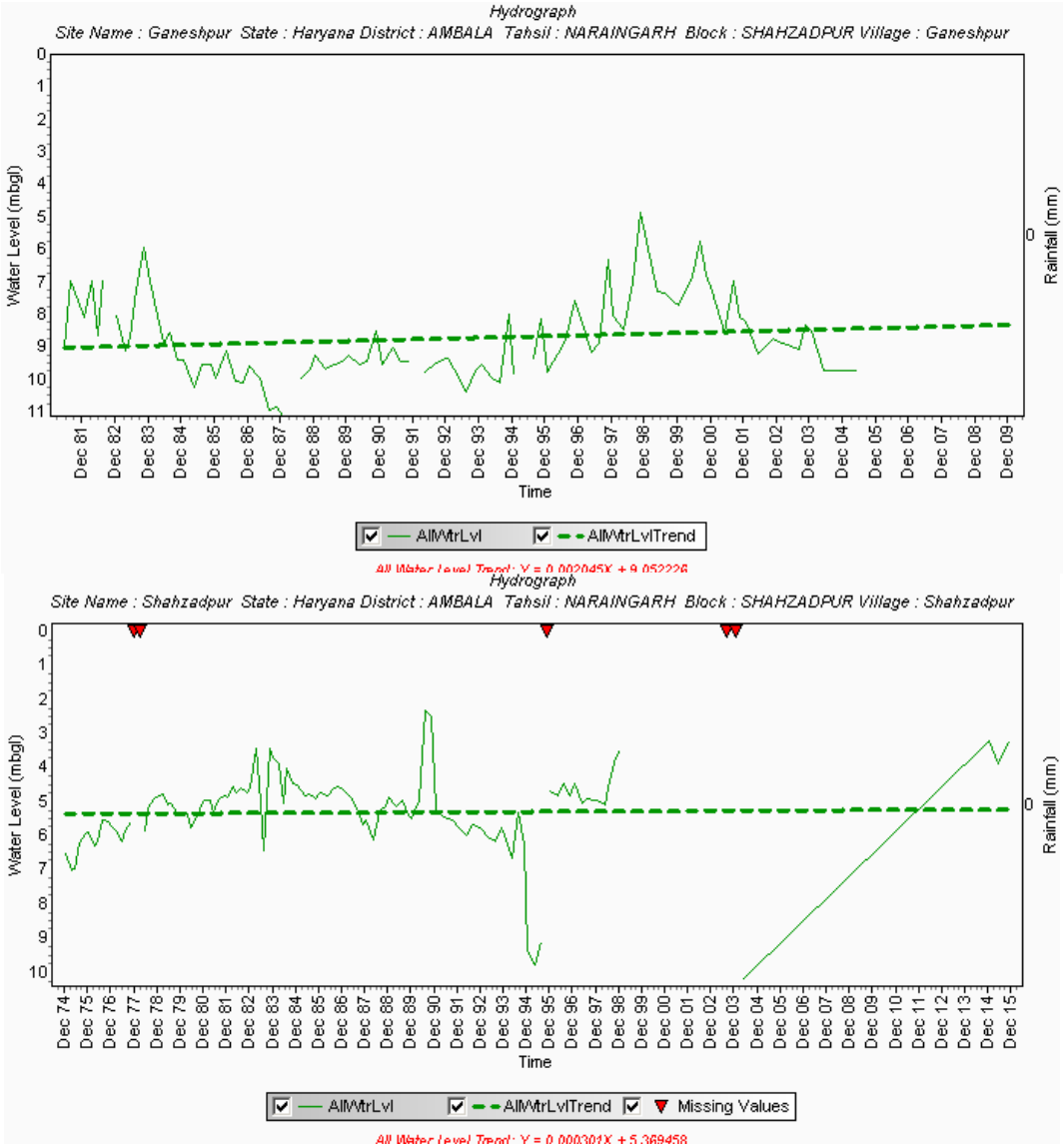
| | |
|---|---|
| **Population (2011)** | Rural-90176 |
| | Urban-8130 |
| | Total-98306 |
| **Rainfall** | Monsoon -1222.40 mm |
| | Non Monsoon-199.80 mm |
| **Average Annual Rainfall** | 1422.20 mm |
| **Agriculture and Irrigation** | Major Crops- Rice, Wheat, Maize, Bajra |
| | Other crops-Barley, Pulses, Oilseeds, Sugarcane, potatoes, chillies |
| | Net Area Sown-177.9sqkm |
| | Total Irrigated Area-158.24sqkm |
| **Water Bodies** | 68 nos. |

**Ground Water Resource Availability**: Ground Water Resources available in the different group of aquifers. Aquifer I (127m) is very prominent in terms of thickness and geographic extent. Aquifer II (62m) is less in thickness. Block is categorized as Semi-Critical as per 2013 assessment.

**Ground water Extraction**: Information regarding the abstraction from Aquifer II is not available, but there are drinking water supply tapping combined aquifer and separate aquifer could not be assessed separately.

**Water level Behavior(2015):**Pre Monsoon-3.6-17.9mbgl & Post Monsoon-2.9-18.4mbgl





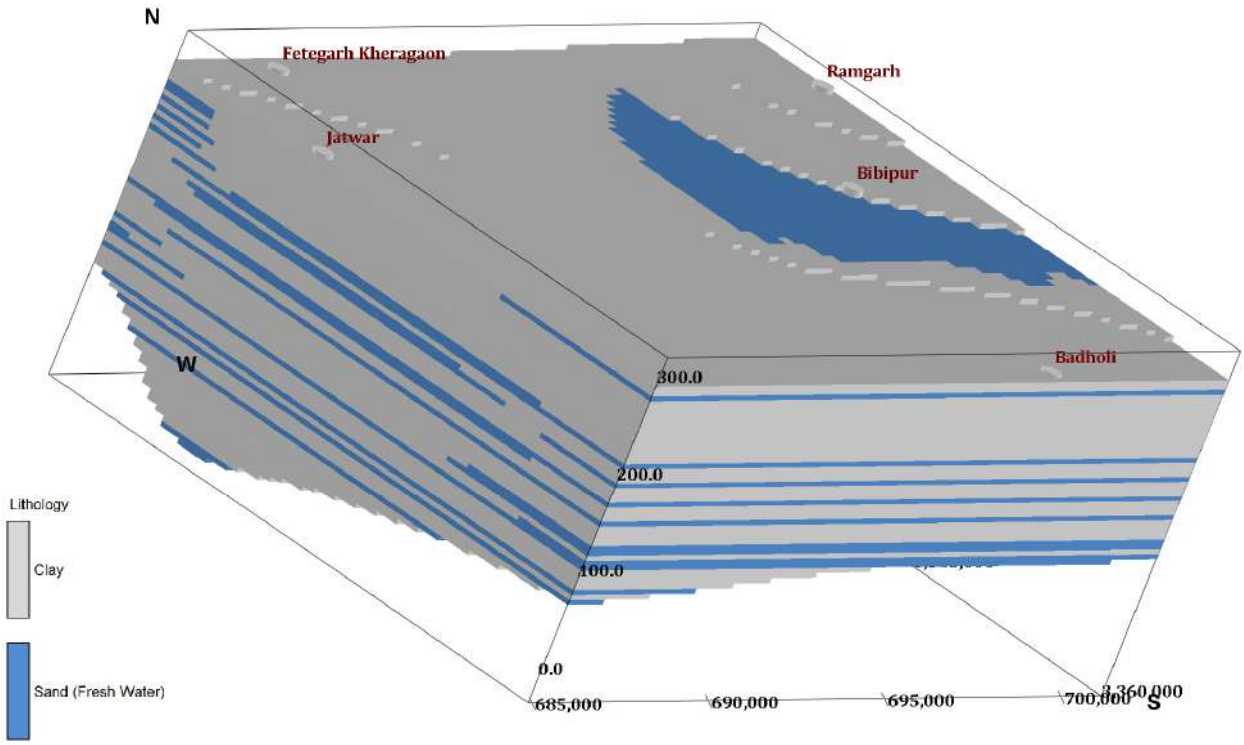

**Aquifer Disposition:** Multiple Aquifer System (2 Aquifer System)

| Aquifer | Geology | Type of Aquifer | Thickness of Granular Zones (m) | Transmissivity ($m^2$/day) | Specific Yield % | Storativity |
|---|---|---|---|---|---|---|
| Aq-I (8-143m) | Quaternary Alluvial deposits | Unconfined | 44 | 786 | 12 | NA |
| Aq-II (207-244m) | | Semi confined to Confined | 22 | - | NA | $1.39x10^{-3}$ |

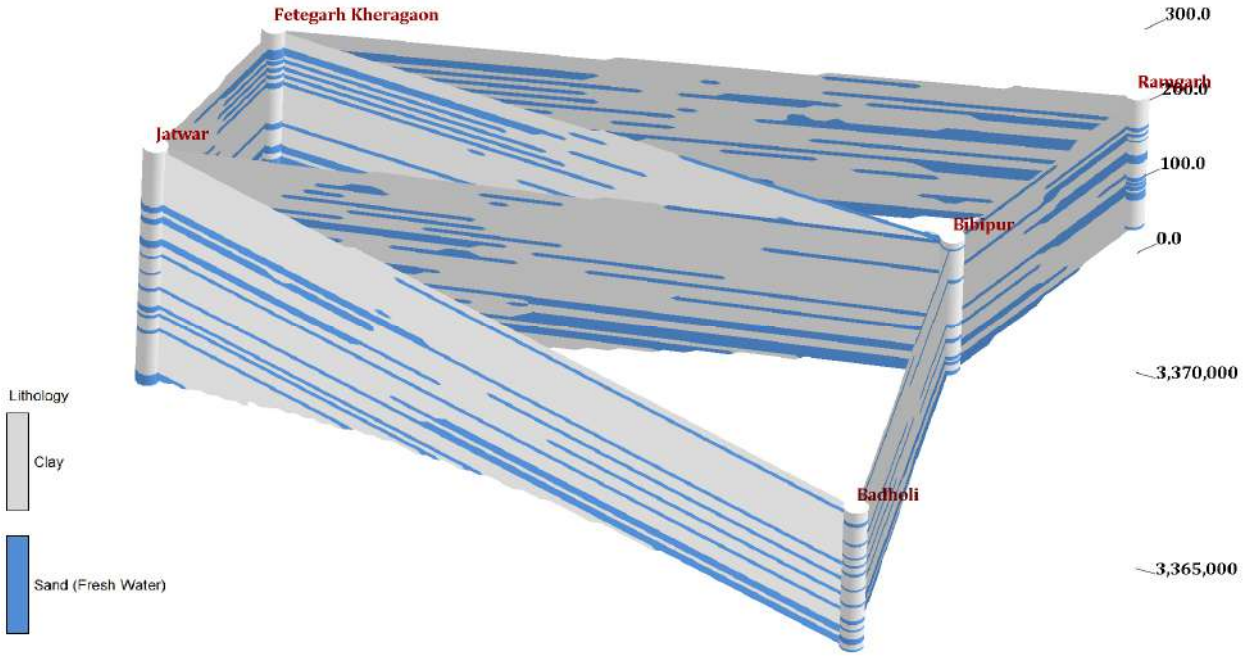
Aquifer comprises of freshwater only and the main aquifer formation is sand.

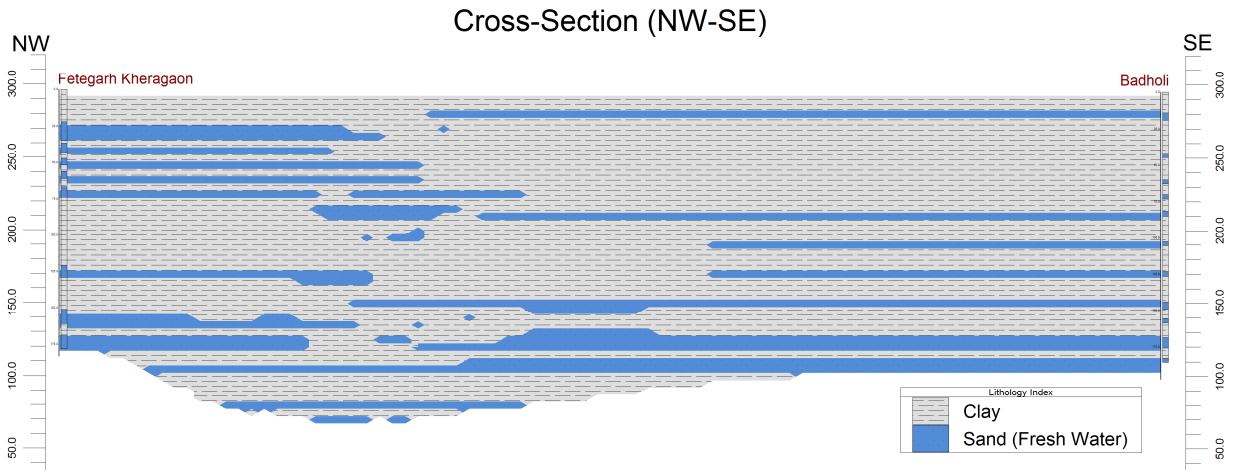
The non-aquifer material comprise of clay.

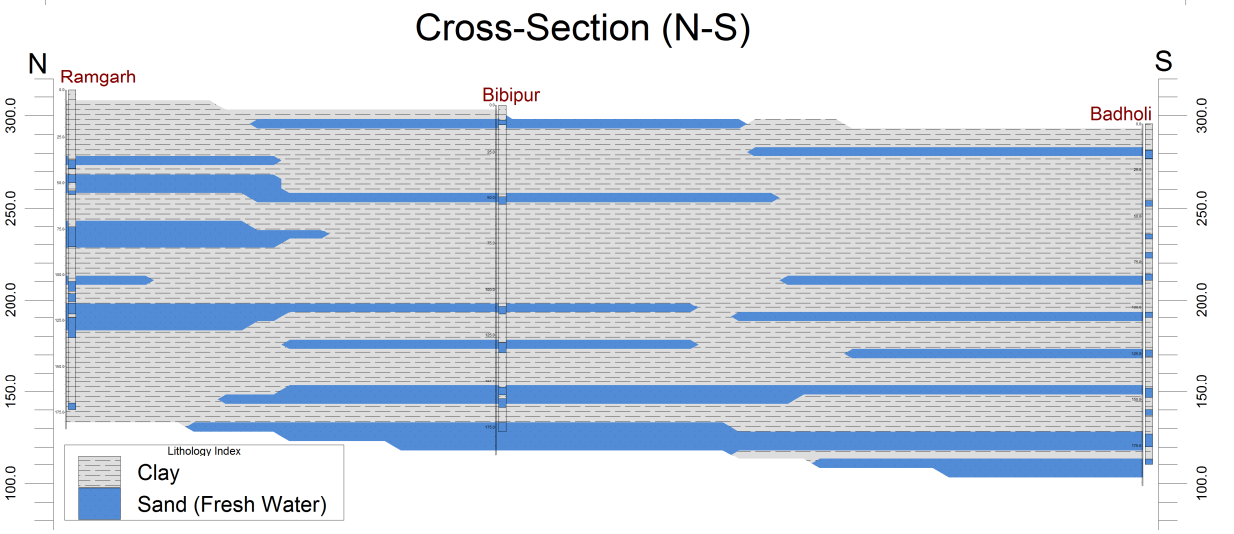
## 3D Lithology model

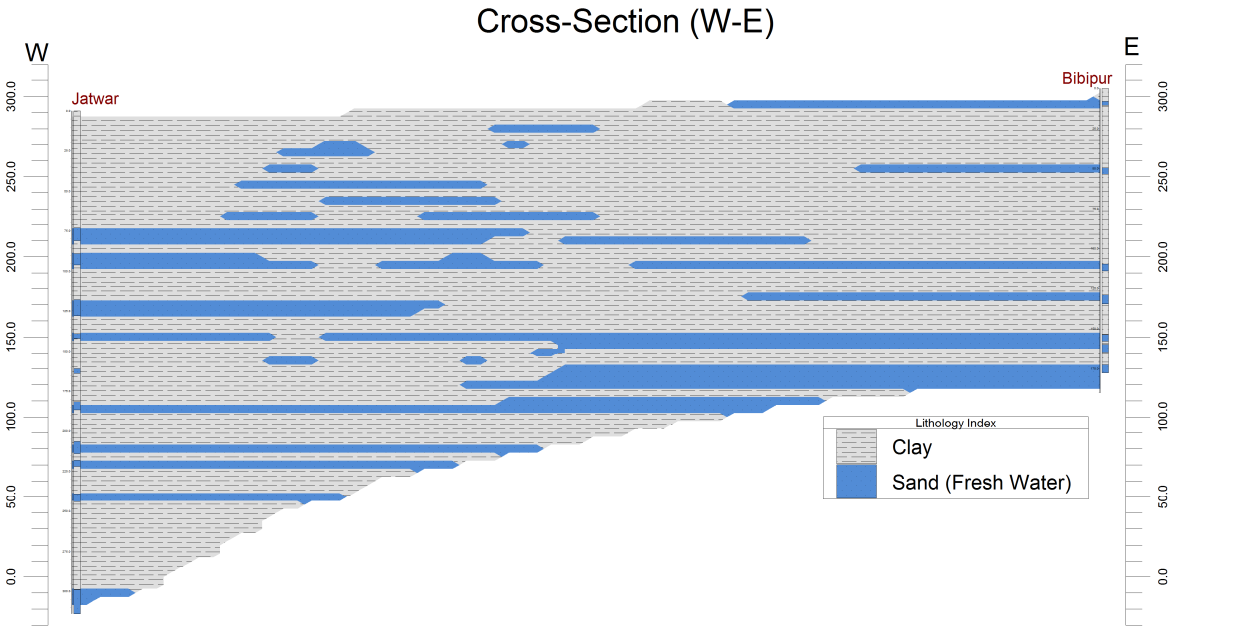



## 3D Lithology Fence

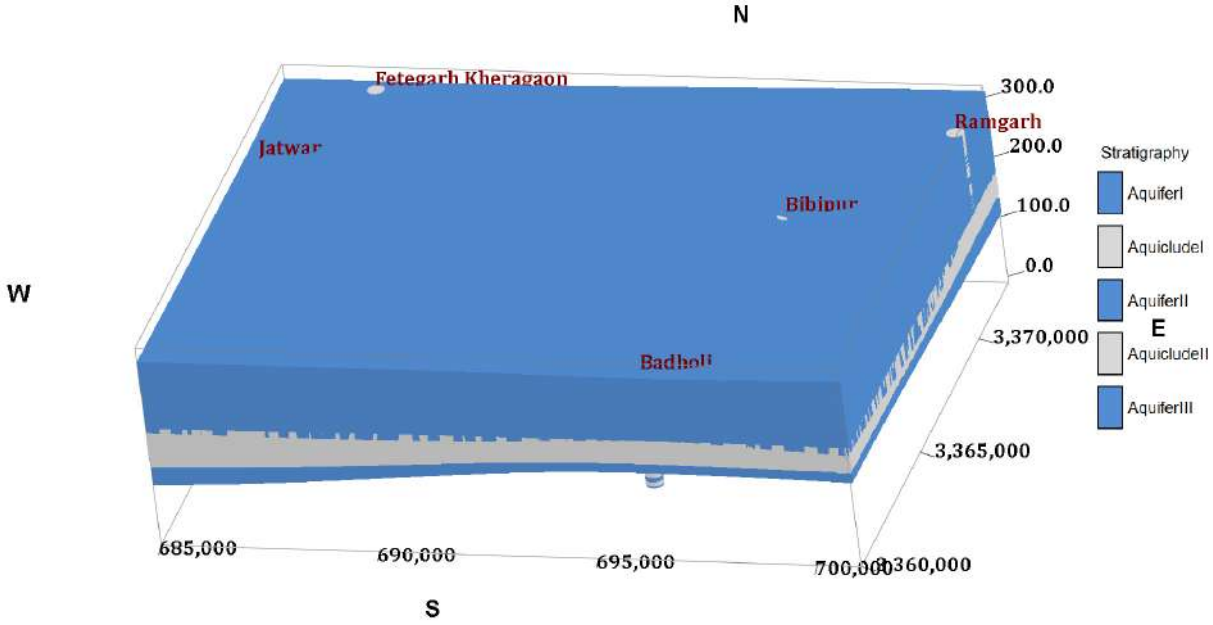



Cross-Section (NW-SE)
NW
SE
Fetegarh Kheragaon
Badholi
300.0
250.0
200.0
150.0
100.0
50.0
Lithology Index
Clay
Sand (Fresh Water)

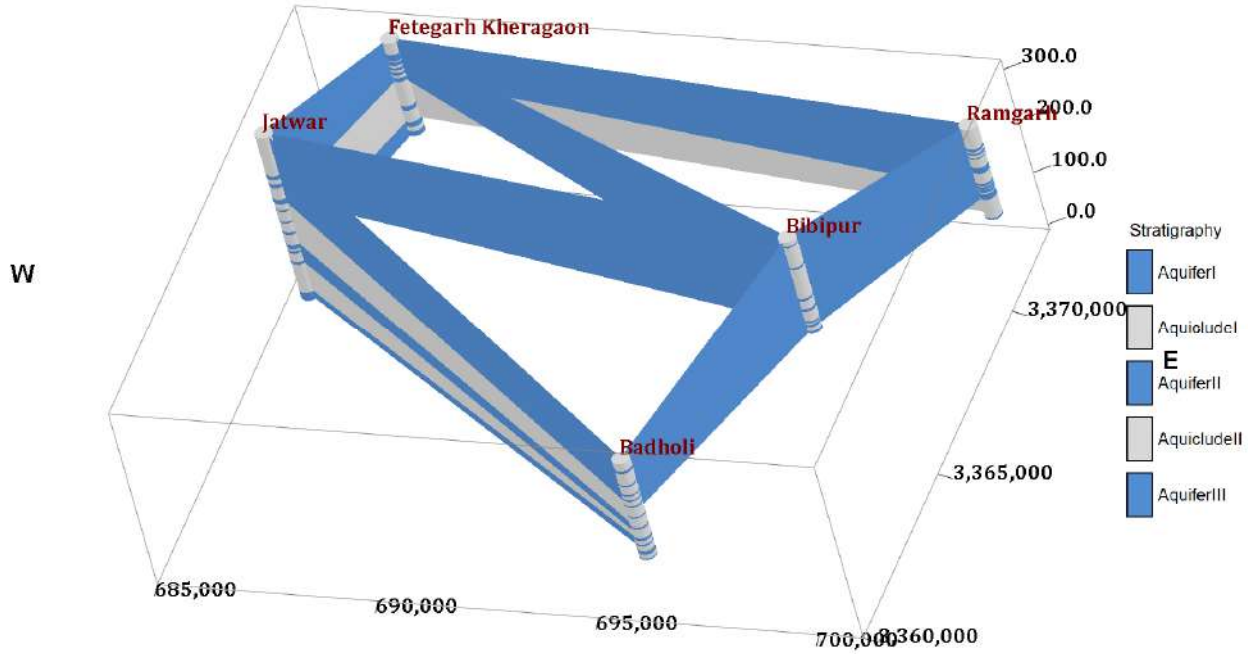

Cross-Section (N-S)
N
S
Ramgarh
Bibipur
Badholi
300.0
250.0
200.0
150.0
100.0
Lithology Index
Clay
Sand (Fresh Water)

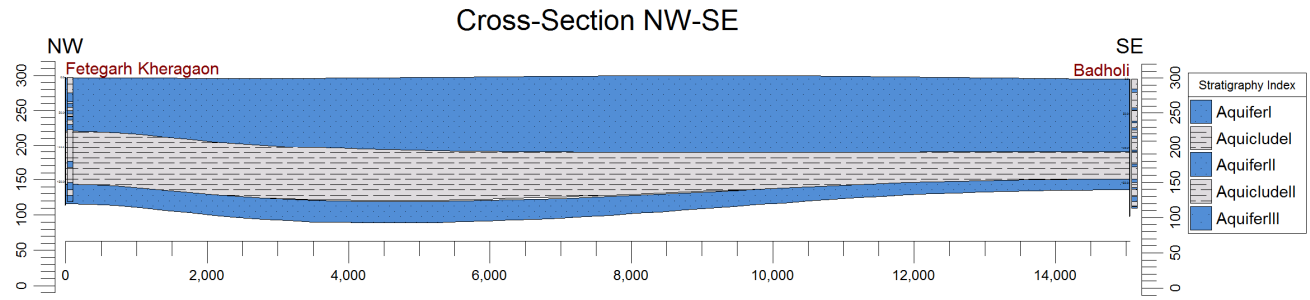

Cross-Section (W-E)
W
E
Jatwar
Bibipur
300.0
250.0
200.0
150.0
100.0
50.0
0.0
Lithology Index
Clay
Sand (Fresh Water)

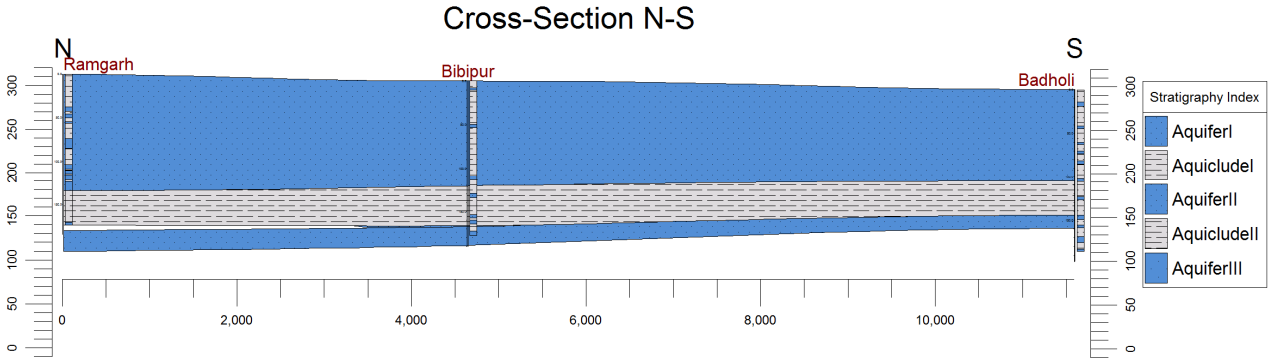
## 3D Aquifer Model




## 3D Aquifer Fence




Cross-Section NW-SE
NW
SE
Fetegarh Kheragaon
Badholi
Stratigraphy Index
AquiferI
AquicludeI
AquiferII
AquicludeII
AquiferIII
0
50
100
150
200
250
300
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000


Cross-Section N-S
N
S
Ramgarh
Bibipur
Badholi
Stratigraphy Index
AquiferI
AquicludeI
AquiferII
AquicludeII
AquiferIII
0
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100
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200
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300
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2,000
4,000
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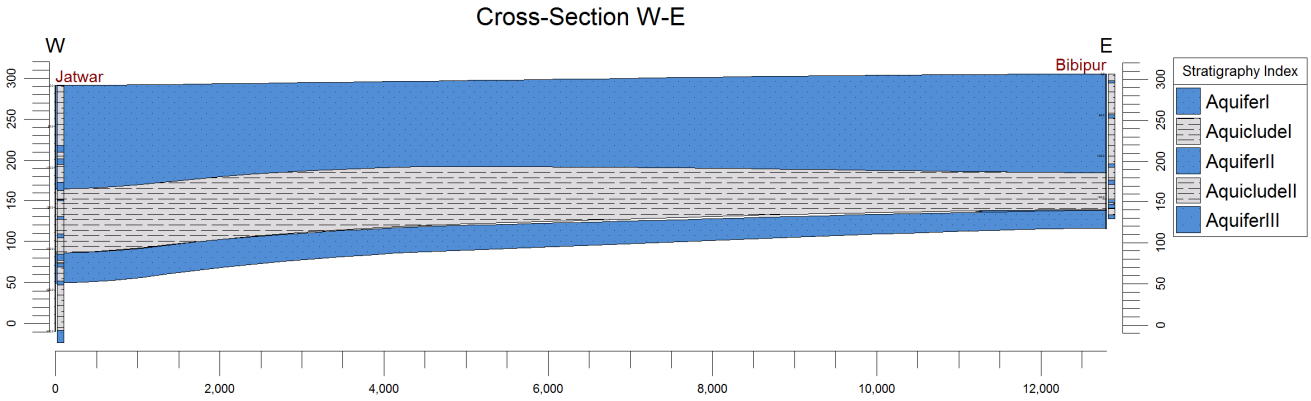
10,000


Cross-Section W-E
W
E
Jatwar
Bibipur
Stratigraphy Index
AquiferI
AquicludeI
AquiferII
AquicludeII
AquiferIII
0
50
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150
200
250
300
0
2,000
4,000
6,000
8,000
10,000
12,000

**Ground Water Resource, Extraction, Contamination and Other Issues**

| | | |
|---|---|---|
| Ground Water Resources (in mcm) | Dynamic Aquifer I (2013) | 92.24 |
| | In-storage Aquifer I (2013) | 902.88 |
| | Dynamic Aquifer II | 67.35 |
| | In-storage Aquifer II | 451.44 |
| | Total | 1513.91 |
| Ground Water Extraction (in mcm) | Irrigation (2013) | 60.07 |
| | Domestic & Industrial (2013) | 12.15 |
| Future Demand for domestic & Industrial sector (2025) (in mcm) | | 1.40 |
| Chemical Quality of ground water | | Potable for drinking and irrigation |
| Other issues | | Deeper water level (>5m) & declining water level trend (35.4-35.9cm/yr) |

**Ground Water Resource Enhancement**

| | |
|---|---|
| Aquifer wise space available for recharge and proposed interventions | Volume of unsaturated zone upto the average depth to water level (14m) is 171 mcm. |
| Other interventions proposed | NA |

**Demand Side Interventions**

| | |
|---|---|
| Advanced Irrigation Practices | Lining of underground pipelines (Kutcha channel) will save 3.96mcm volume of water wastage |
| Change in cropping pattern | NA |
| Alternate water sources | Tanks, ponds and canals |
| Regulation and Control | - |
| Other interventions proposed, if any | - |

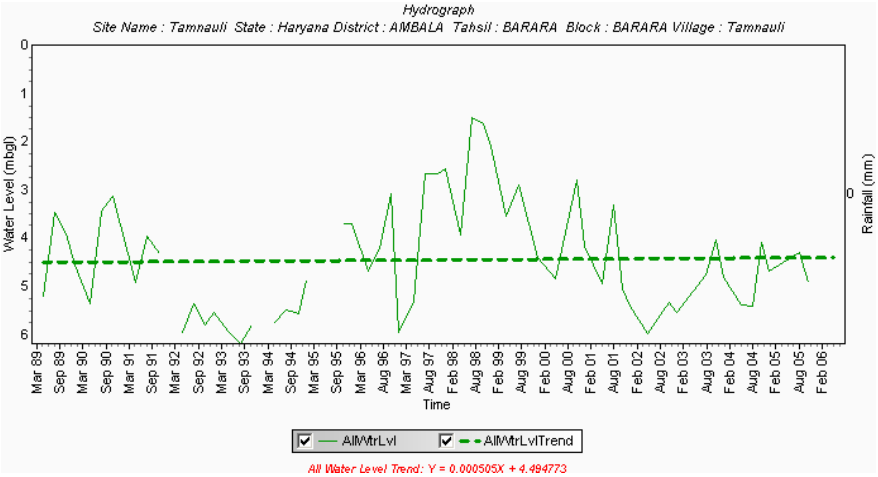
## vi. SAHA BLOCK (239.67 Sq. km.)

| | |
|---|---|
| **Population (2011)** | Rural-97771 |
| | Urban-8100 |
| | Total-105871 |
| **Rainfall** | Monsoon -440mm |
| | Non Monsoon-144.40mm |
| **Average Annual Rainfall** | 585mm |
| **Agriculture and Irrigation** | Major Crops- Rice, Wheat, Maize, Bajra |
| | Other crops-Barley, Pulses, Oilseeds, Sugarcane, potatoes, chillies |
| | Net Area Sown-177.44sqkm |
| | Total Irrigated Area-174.96sqkm |
| **Water Bodies** | 50 nos. |

**Ground Water Resource Availability**: Ground Water Resources available in the different group of aquifers. Aquifer I (127m) is very prominent in terms of thickness and geographic extent. Aquifer II (62m) is less in thickness. Block is categorized as Over-Exploited as per 2013 assessment.

**Ground water Extraction**: Information regarding the abstraction from Aquifer II is not available, but there are drinking water supply tapping combined aquifer and separate aquifer could not be assessed separately.

**Water level Behavior (2015):**Pre Monsoon-2.9-35.7mbgl & Post Monsoon-2.1-35.7mbgl

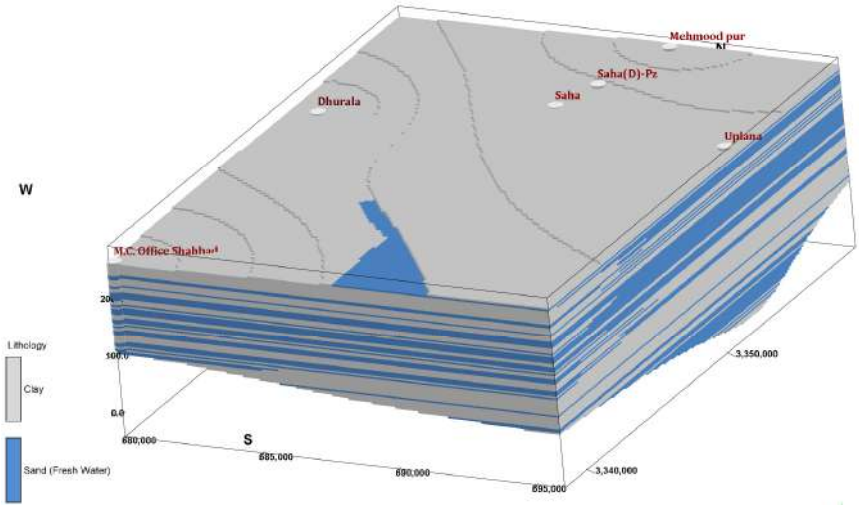


**Aquifer Disposition:** Multiple Aquifer System (2 Aquifer System)

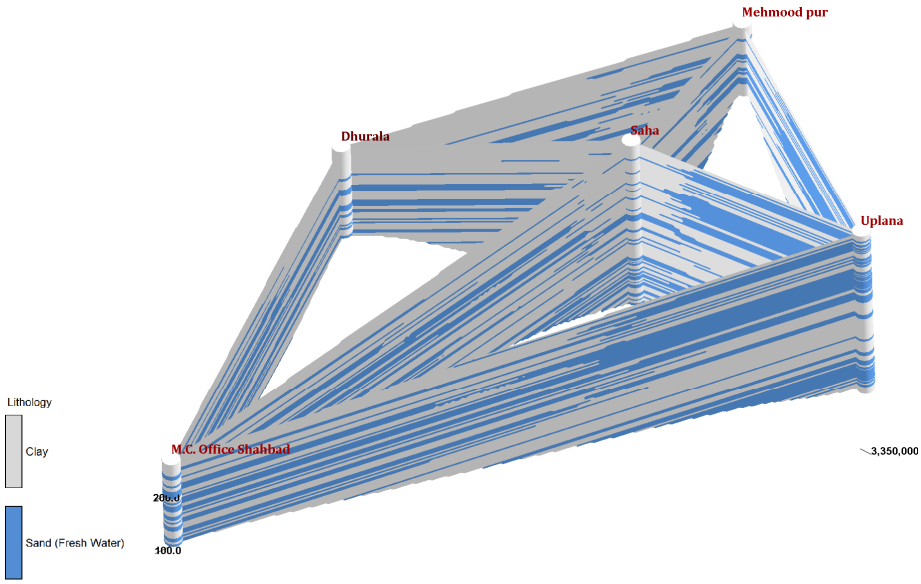
| Aquifer | Geology | Type of Aquifer | Thickness of Granular Zones (m) | Transmissivity ($m^2$/day) | Specific Yield % | Storativity |
|---|---|---|---|---|---|---|
| Aq-I (3-130m) | Quaternary Alluvial deposits | Unconfined | 46.4 | 1710 | 12 | NA |
| Aq-II (217-279m) | | Semi confined to Confined | 43 | - | NA | $1.39x10^{-3}$ |

Aquifer comprises of freshwater only and the main aquifer formation is sand.
The non-aquifer material comprise of clay.

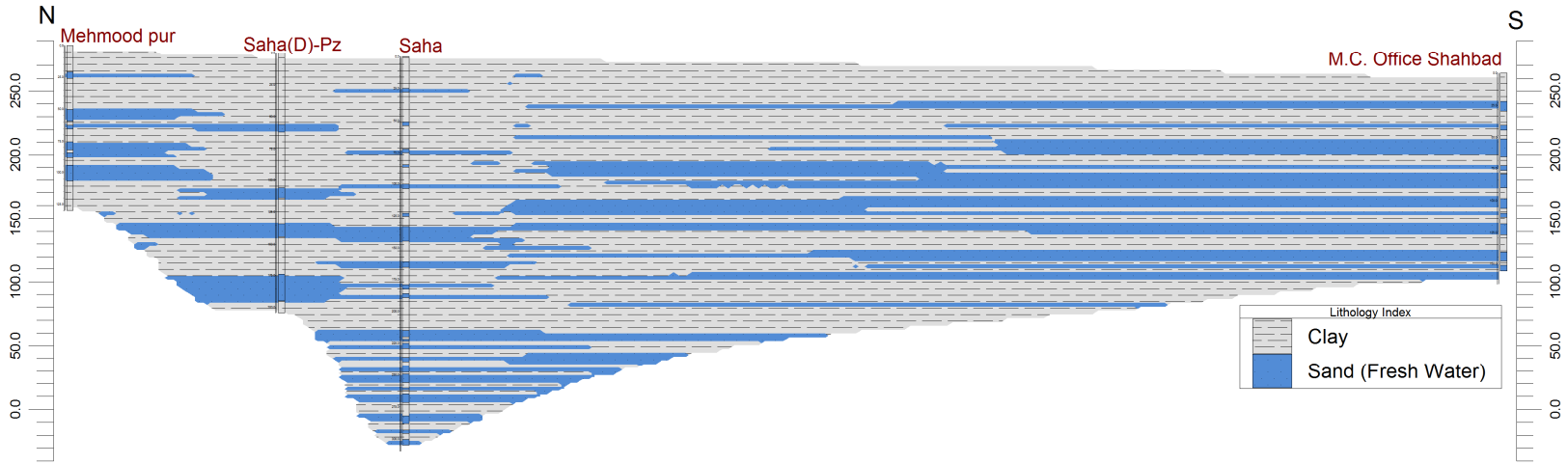
**3D Lithology model**



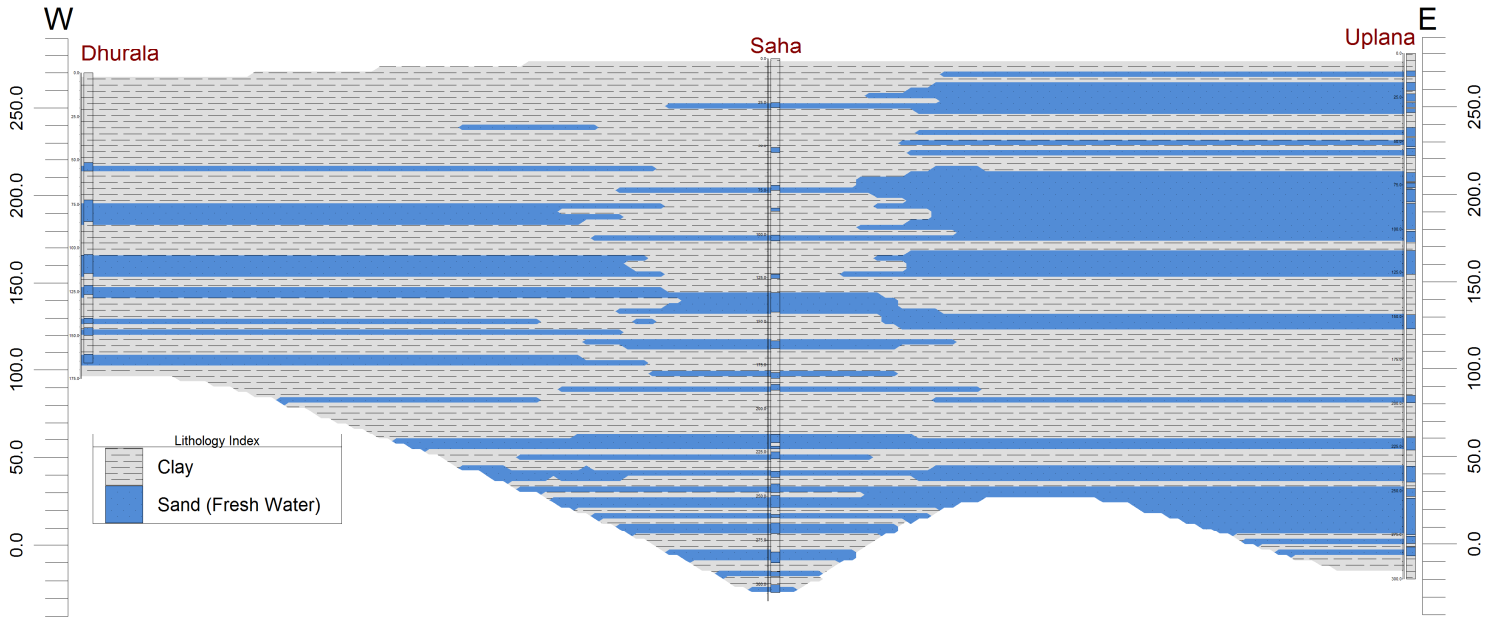

**3D Lithology Fence**



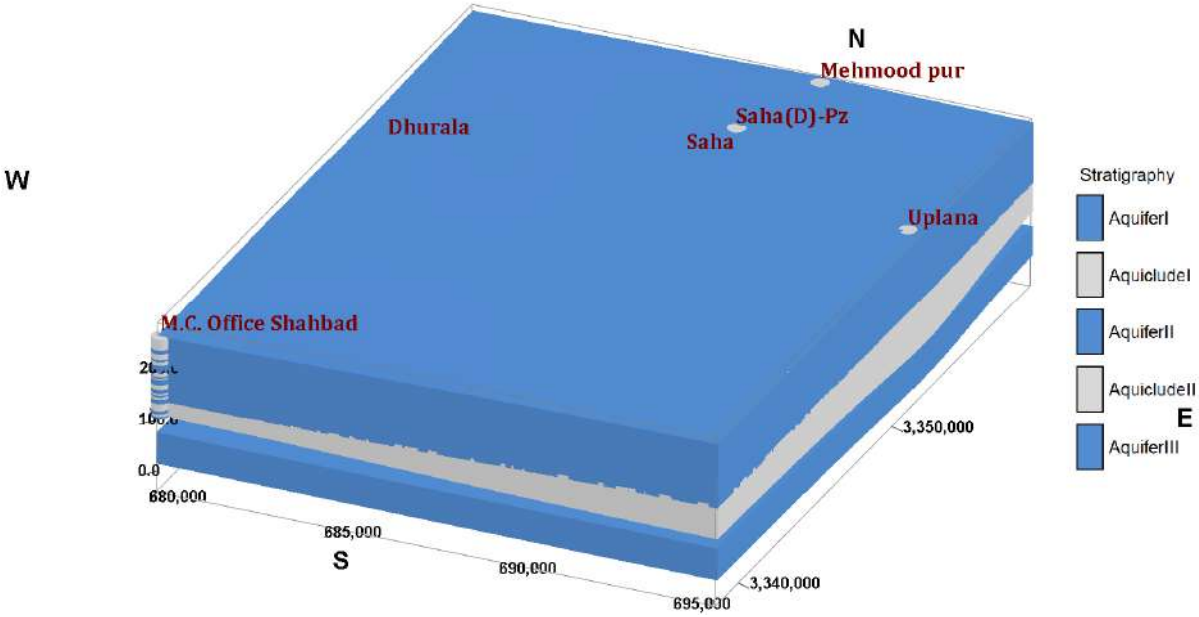
## Cross-Section (N-S)



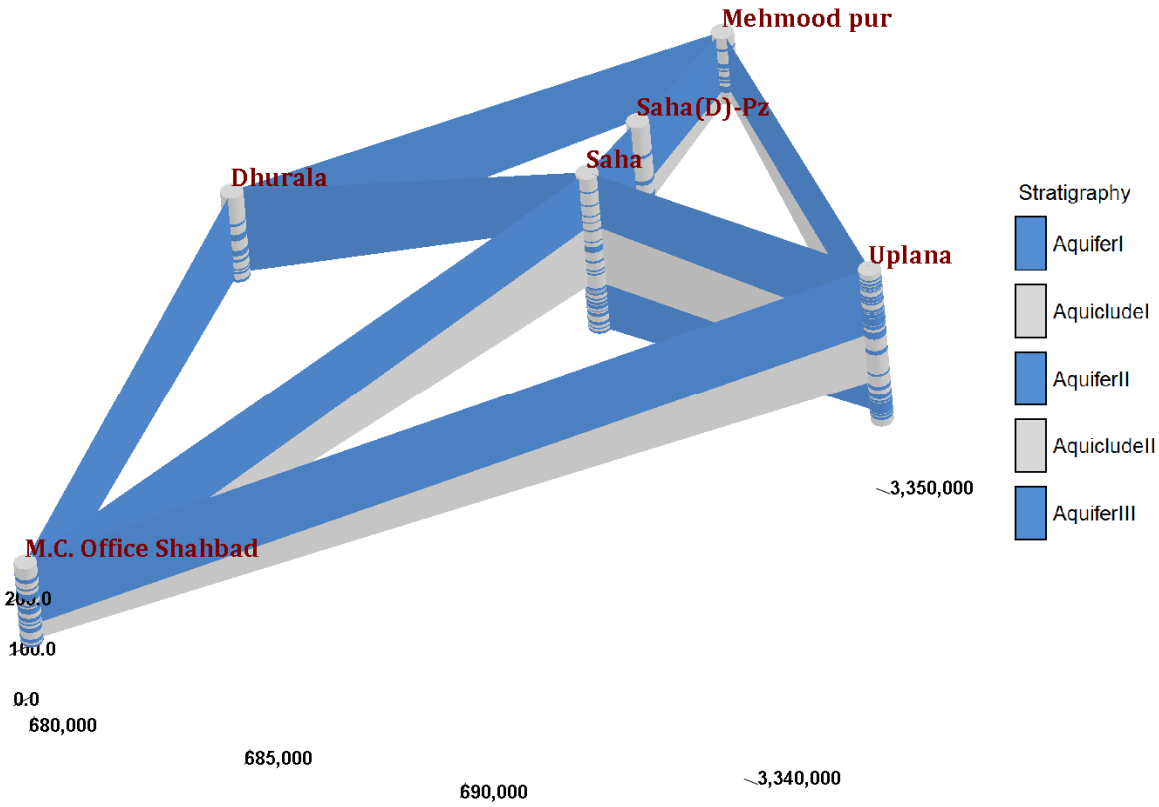

## Cross-Section W-E

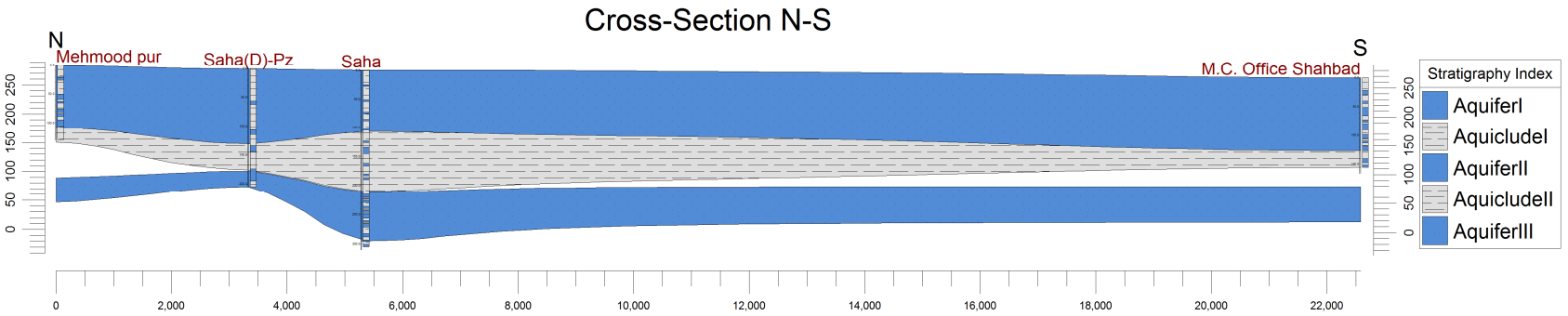


## 3D Aquifer Model




## 3D Aquifer Fence




Cross-Section N-S
N
S
Mehmood pur
Saha(D)-Pz
Saha
M.C. Office Shahbad
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150
200
250
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4,000
6,000
8,000
10,000
12,000
14,000
16,000
18,000
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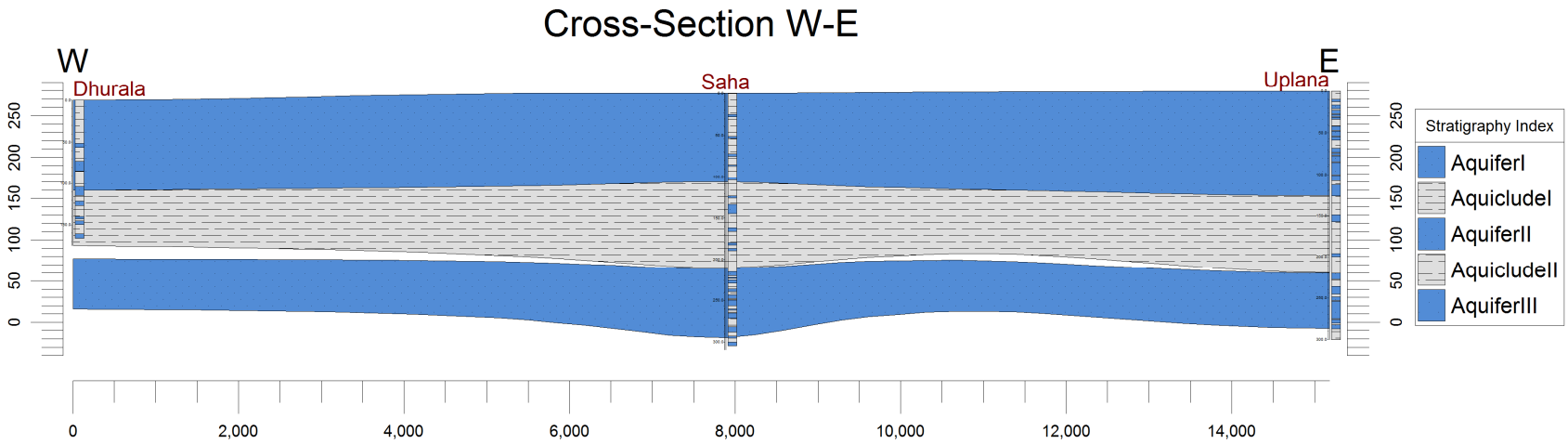
22,000
Stratigraphy Index
AquiferI
AquicludeI
AquiferII
AquicludeII
AquiferIII


Cross-Section W-E
W
E
Dhurala
Saha
Uplana
0
50
100
150
200
250
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
Stratigraphy Index
AquiferI
AquicludeI
AquiferII
AquicludeII
AquiferIII

**Ground Water Resource, Extraction, Contamination and Other Issues**

| | | |
|---|---|---|
| Ground Water Resources (in mcm) | Dynamic Aquifer I (2013) | 74.29 |
| | In-storage Aquifer I (2013) | 800.69 |
| | Dynamic Aquifer II | 60.13 |
| | In-storage Aquifer II | 733.39 |
| | Total | 1668.5 |
| Ground Water Extraction (in mcm) | Irrigation (2013) | 85.72 |
| | Domestic & Industrial (2013) | 10.80 |
| Future Demand for domestic & Industrial sector (2025) (in mcm) | | 10.80 |
| Chemical Quality of ground water | | Potable for drinking and irrigation |
| Other issues | | Deeper water level (>5m) & declining water level trend (70.3-85.1cm/yr) |

**Ground Water Resource Enhancement**

| | |
|---|---|
| Aquifer wise space available for recharge and proposed interventions | Volume of unsaturated zone upto the average depth to water level (3.7m) is 0 mcm. |
| Other interventions proposed | Artificial Recharge, Roof top Rainwater Harvesting will save 0.2mcm volume of water |

**Demand Side Interventions**

| | |
|---|---|
| Advanced Irrigation Practices | Lining of underground pipelines (Kutcha channel) will save 5.66 mcm volume of water wastage |
| Change in cropping pattern | Proposed change in cropping pattern from Paddy to maize/soyabean in 20% area of the block.<br>Anticipated volume of water to be saved by maize is 16.33mcm. |
| Alternate water sources | Tanks, ponds and canals |
| Regulation and Control | No, Not notified |
| Other interventions proposed, if any | - |

## 8. Conclusions

- ✓ The area of Ambala district belongs to Ghaggar Basin and occupied by geological formations of Quaternary age with three aquifer system up to 300 meter depth.
- ✓ The major aquifer system of the Ambala district is alluvial deposits.
- ✓ The major lithological formations are sand , gravel & clay and silt.
- ✓ The sand is inter-layered with clay and clay thickness decreases from north to south. The clay dominates over sand in the whole district.
- ✓ Thick layers of clay occur at site Race Course ( Ambala Cantt.) and the maximum thickness of clay is 172m.
- ✓ In general the ground water is fresh in the Ambala district. Arsenic concentration of 0.058 mg/l has been found more than the permissible limit at village Balana in Ambala-II block. Ambala –I, Saha and Barara blocks have high iron concentration in ground water.
- ✓ As per Ground water resource estimation as on March 2013, The stage of ground water development ranges between 80% (block-Ambala I) to 130% (block- Saha).
- ✓ Out of six blocks of the district, three blocks are over exploited ( Barara, Naraingarh & Saha), two blocks falls under semi critical category ( Ambala-II & Shazadpur) and one bloc is safe (Ambala-I).
- ✓ The net ground water availability is 56306 ham, and existing gross ground water draft for all uses is 57466 and net ground water availability for future irrigation development is 1675 ham. The stage of ground water development in the district is 102%.
- ✓ The ground water development in three blocks has exceeded the available recharge, thus these blocks have been categorized as over exploited. Stage of these blocks ranges from 121% to 130%.
- ✓ Dynamic & In- storage ground water resources has also been carried out to a depth of 300 meters for all aquifer groups.
- ✓ Dynamic ground water resources of the district are 0.563 BCM and fresh in storage ground water resources of Ambala district are 5.933 BCM. Thus total Ground water resources of Aquifer-I are 6.496 BCM.

- ✓ Total ground water resources of Aquifer-II are 4.080 BCM and for Aquifer –III are 1.426 BCM
- ✓ Total ground water resources up to 300 m depth are 12.002 BCM. The ground water resources of the Aquifer-I are more than the total of ground water resources of Aquifer II & Aquifer-III in the district.
- ✓ Considering the high ground water abstraction (1151.4 mcm) and overdraft (129.60 mcm), it is suggested that proposed artificial recharge measures (12.2 mcm), crop diversification measures (59.4 mcm) and conserving ground water through laying of pipe line (78.4 mcm) will be useful.
- ✓ There are around 5027 (out of 19041) tubewells (26.40%) operated by farmers for irrigation through unlined/Katcha open channel system in Ambala district where water from the tubewell is discharge to the agricultural field. In this process, huge (upto 25%) quantity of ground water is wasted in soil moisture and evaporation losses.
- ✓ Around 76% of the tube wells are of in depth range of upto 70 meters and remaining are deeper (70-110 m) depth in the district. Thus majority of wells are tapping Aquifer group-I which is under stress due to overexploitation.
- ✓ Dynamic ground water resources (2013) indicate that Gross ground water draft for irrigation in Ambala district is estimated at 497.56 MCM. It is expected that around 25% of over draft can be brought down by switching over to underground/surface pipeline based distribution from the prevailing unlined open channels. Thereby gross draft will be reduced to the tune of 32.83 MCM assuming there is no crop diversification by the farmers.
- ✓ In addition to that by adopting artificial recharge to ground water 1.9 MCM of overdraft can be reduced and by change of cropping pattern from Paddy to Maze in 8% to 20 % area in over exploited blocks 45 MCM draft can be reduced.
- ✓ By adopting all the measures stage of development in the district can be reduced to 88% from the present 102%.

## ANNEXURE I: Depth to water level of GWOW (2015)

| S. No. | Location | Latitude | Longitude | Water Level | | Fluctuation |
|---|---|---|---|---|---|---|
| | | | | May | Nov | |
| 1 | Ambala Cantt | 30°23'00'' N | 76°45'45'' E | 2.25 | 1.78 | 0.47 |
| 2 | Ambala Cantt-Pz | 30°22'00'' N | 76°50'00'' E | 5.51 | 3.50 | 2.01 |
| 3 | Ambala City-DW | 30°23'00'' N | 76°44'00'' E | 1.09 | 0.99 | 0.10 |
| 4 | Balana | 30°19'15'' N | 76°43'45'' E | - | 1.40 | - |
| 5 | Barara S | 30°13'00'' N | 77°03'00'' E | 5.30 | 4.90 | 0.40 |
| 6 | Barara-Pz | 30°13'00'' N | 77°03'00'' E | 20.17 | 19.15 | 1.02 |
| 7 | Bari Bassi-DW | 30°27'46'' N | 77°04'20'' E | - | 9.75 | - |
| 8 | Bhuragnpur-DW | 30°17'00'' N | 76°39'00'' E | 4.58 | 4.08 | 0.50 |
| 9 | Bhurewala-Pz | 30°30'00'' N | 77°05'00'' E | 8.97 | 7.70 | 1.27 |
| 10 | Bichali Dhamouli-Pz | 30°23'00'' N | 77°01'00'' E | 7.75 | 7.15 | 0.60 |
| 11 | Boh-DW | 30°22'13'' N | 76°52'23'' E | - | 1.91 | - |
| 12 | Budhha Khera-DW | 30°20'52'' N | 77°05'02'' E | - | 6.78 | - |
| 13 | Bullana- DW | 30°22'39'' N | 76°46'31'' E | - | 0.70 | - |
| 14 | Chhapra-DW | 30°15'42'' N | 76°59'20'' E | - | 7.00 | - |
| 15 | Churmastpur-DW | 30°17'00'' N | 76°40'00'' E | 8.21 | 4.29 | 3.92 |
| 16 | Dhanaura | 30°17'45'' N | 77°07'00'' E | 5.62 | 3.24 | 2.38 |
| 17 | Dukheri-DW | 30°16'50'' N | 76°52'51'' E | - | 2.60 | - |
| 18 | Hasanpur-DW | 30°14'19'' N | 76°42'22'' E | - | 6.01 | - |
| 19 | Jansui-DW | 30°12'27'' N | 76°41'07'' E | - | 1.32 | - |
| 20 | Jauli-DW | 30°21'00'' N | 77°05'00'' E | 20.15 | 18.40 | 1.75 |
| 21 | Kakkar Majra-DW | 30°27'16'' N | 77°01'20'' E | - | 10.70 | - |
| 22 | Kakru | 30°24'30'' N | 76°47'15'' E | 1.96 | 1.32 | 0.64 |
| 23 | Kalumazra-DW | 30°14'55'' N | 76°45'45'' E | - | 2.35 | - |
| 24 | Kapoori At Saphera-PZ | 30°20'26'' N | 76°55'42'' E | - | 11.20 | - |
| 25 | Khanahmadpur | 30°14'30'' N | 77°07'30'' E | 3.80 | 2.83 | 0.97 |
| 26 | Khanna Majra | 30°14'52'' N | 76°39'26'' E | - | 1.60 | - |
| 27 | Mohra-DW | 30°16'00'' N | 76°51'00'' E | 3.60 | 1.75 | 1.85 |
| 28 | Mulana | 30°17'00'' N | 77°02'45'' E | 2.94 | 2.12 | 0.82 |
| 29 | Nanhera-DW | 30°18'40'' N | 76°50'46'' E | - | 17.57 | - |
| 30 | Naraingarh | 30°28'15'' N | 77°07'30'' E | 11.31 | 12.02 | -0.71 |
| 31 | Naraingarh-Pz | 30°28'00'' N | 77°07'00'' E | 9.45 | 11.68 | -2.23 |
| 32 | Nasirpur-Pz | 30°21'00'' N | 76°46'00'' E | 1.20 | 1.10 | 0.10 |
| 33 | Nikuwana-DW | 30°23'00'' N | 77°05'00'' E | 17.89 | 18.40 | -0.51 |
| 34 | Panjokhra | 30°24'30'' N | 76°50'45'' E | 5.24 | 4.51 | 0.73 |
| 35 | Patvi | 30°26'04'' N | 76°57'18'' E | - | 13.35 | - |

| | | | | | | |
|---|---|---|---|---|---|---|
| 36 | Pinjola | 30°15'45'' N | 76°36'50'' E | 5.45 | 4.19 | 1.26 |
| 37 | Saha-Pz | 30°19'00'' N | 76°59'00'' E | 35.69 | 35.67 | 0.02 |
| 38 | Salehpur-DW | 30°15'16'' N | 77°05'20'' E | - | 2.99 | - |
| 39 | Shahpur-DW | 30°18'00'' N | 77°05'00'' E | 10.67 | 8.72 | 1.95 |
| 40 | Shahzadpur | 30°26'00'' N | 77°01'00'' E | 3.91 | 3.21 | 0.70 |
| 41 | Shahzadpur-Pz | 30°26'00'' N | 77°01'00'' E | 3.55 | 2.47 | 1.08 |
| 42 | Sohana-DW | 30°15'14'' N | 77°01'35'' E | - | 3.97 | - |
| 43 | Tandwal-DW | 30°14'04'' N | 76°59'04'' E | - | 3.80 | - |
| 44 | Tejan-DW | 30°17'00'' N | 76°45'00'' E | 4.48 | 3.33 | 1.15 |
| 45 | Tharwa-DW | 30°11'35'' N | 76°58'42' E | - | 2.60 | - |
| 46 | Ugala S | 30°16'48'' N | 76°47'11'' E | 34.30 | 34.20 | 0.10 |

## ANNEXURE II: Results of chemical analysis of water samples from NHS (2015)

| Sr. No | Location | Block | pH | EC in µS/cm at 250C | CO3 | HCO3 | Cl | SO4 | NO3 | F | PO4 | Ca | Mg | Na | K | SiO2 | T.H as CaCO3 | As | Fe |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | (----------mg/l----------) | | | | | | | | | | | | | | |
| 1 | Balana | Ambala II | 8.45 | **2255** | 53 | 672 | 184 | 195 | **90** | 0.3 | 0.71 | 114 | 35 | 270 | 128 | 30 | 429 | **0.058** | 0.008 |
| 2 | Pinjora | Ambala II | **8.75** | 855 | 35 | 202 | 63 | 121 | 1 | 0.93 | 0.14 | 12 | 5 | 180 | 2.4 | 14 | 51 | 0.008 | 0.1764 |
| 3 | Ambala Cantt. | Ambala I | **8.85** | 1250 | 59 | 547 | 35 | 106 | BDL | 0.89 | 0.03 | 12 | 17 | 282 | 0.5 | 13 | 102 | 0.002 | **0.843** |
| 4 | Kakru | Ambala I | 8.22 | **2650** | Nil | 654 | 243 | 360 | **135** | 0.46 | BDL | 65 | 32 | 330 | 280 | 30 | 296 | 0.005 | 0.1338 |
| 5 | Panjokera | Ambala I | 8.45 | **2997** | 35 | 416 | 347 | **418** | **250** | 0.66 | 0.06 | 65 | 77 | 390 | 160 | 18 | 480 | 0.002 | BDL |
| 6 | Narain-garh | Narain-garh | ------- | | | | | | | | | | | | | | | 0.001 | 0.26 |
| 7 | Mullana | Saha | **8.64** | 509 | 35 | 226 | 49 | 6 | 8.1 | 0.4 | 0.07 | 8 | 15 | 115 | 1.8 | 18 | 82 | 0.003 | **2.446** |
| 8 | Dhanura | Barara | 8.19 | 704 | Nil | 226 | 49 | 118 | BDL | 0.14 | 0.01 | 45 | 12 | 98 | 2.7 | 22 | 163 | 0.008 | **8.428** |
| 9 | Khan Amdalpura | Barara | **8.52** | 1940 | 117 | 297 | 215 | 185 | **80** | 0.6 | 0.01 | 27 | 43 | 350 | 3 | 9 | 245 | 0.001 | 0.14 |
| 10 | Saha | Saha | **8.75** | 524 | 59 | 178 | 28 | 15 | 8.5 | 0.41 | BDL | 20 | 21 | 78 | 1.2 | 20 | 138 | 0.001 | 0.1447 |
| 11 | Uplana | Saha | 8.26 | 425 | Nil | 262 | 6.9 | 10 | 3 | 0.23 | BDL | 45 | 16 | 27 | 2.3 | 23 | 179 | 0.001 | BDL |

The values more than the permissible limits (BIS Standard 2012) are shown in red colour.

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**Preparation of the report**

**Technical discussion and Data Validation**